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Popular Science®

The What's New magazine

New workers on the assembly line:

ROBOTS THAT THINK

Solar collector/converter moves heat in chemical form

PS previews the '81 CARS

Build it from a kit: 6-FOOT PROJECTION TV

For your 2001 car? FREE-PISTON ENGINE

New COMPACT BENCH TOOLS do big jobs in small shops

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TOUGH FORD COURIER

The Gas Mileage Champ of the best-selling compacts.

Ford Courier is the gas mileage champ of the best-selling compacts. Up to 29% better than the competition. Courier's EPA rating is better than Datsun, better than Toyota, better than Chevrolet LUV. And Courier beats the competition for the fourth straight year! Courier's built tough, too. With rugged ladder-type frame, 6-leaf progressive rear springs, standard front stabilizer bar, and power brakes... 2L and optional 2.3L engines. And see your Ford Dealer for full details on Ford's new corrosion perforation warranty. It's a no-cost 36-month limited warranty that excludes exhaust system components. Ask about Ford's Extended Service Plan, too.

Courier Sport Group. Package includes plaid buckets, woodtone instrument panel, sport steering wheel, gauges and carpet.

Free Wheeling Courier. Custom-ordered look. Black-painted GT bar and push bar. Add "B" Package for tape stripes, cast aluminum wheels and RWL tires.

For big loads. 1400-lbs. payload rating, 7-ft. box option.

Tough Ford Courier

OFFICIAL 1980 EPA RATINGS SHOW

	BEST MPG RATING		LONGEST RANGE	
	EPA EST.	HWY. EST.	EST. MILES	HWY. MILES
FORD COURIER	27	37	473	647
BETTER THAN TOYOTA	21	28	338	451
BETTER THAN DATSUN	25	32	423	541
BETTER THAN LUV	25	35	325	455

Use estimates for comparison. Your mileage and range may differ depending on speed, distance and weather. Actual hwy. mileage and range will probably be less than estimated. Fuel tank capacities (gal.) for LWB models. Courier 17.5, Toyota 16.1, Datsun 16.9, LUV 13.0. Calif. estimates lower.

FORD

FORD DIVISION

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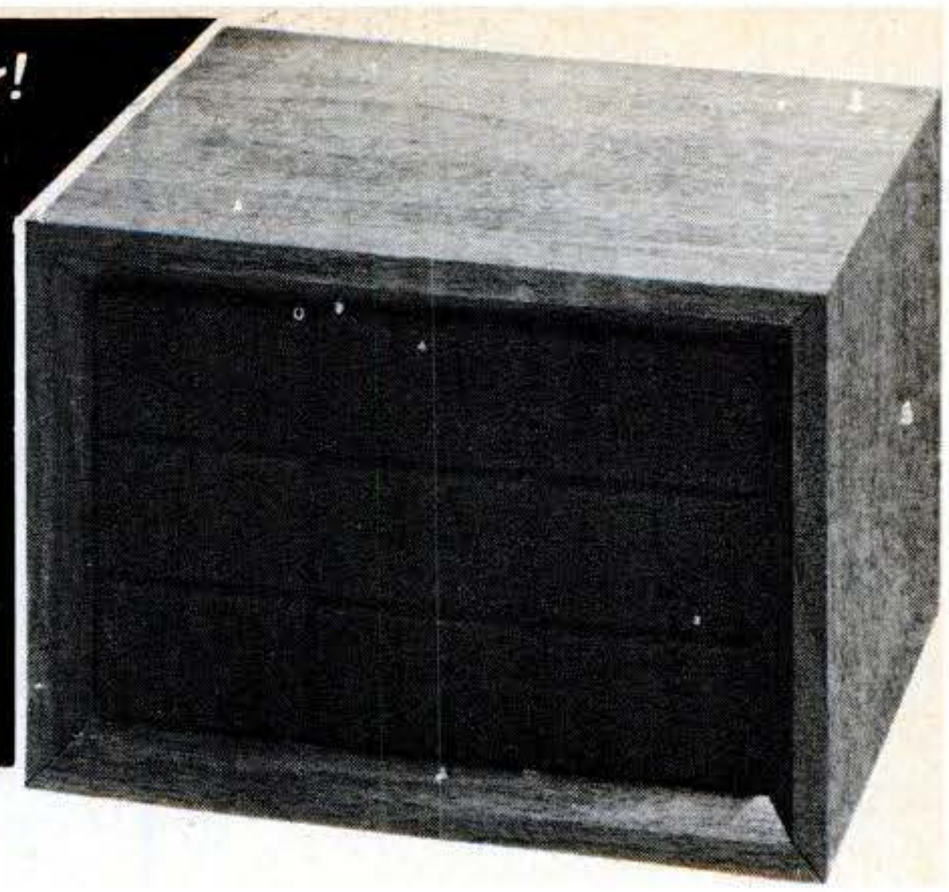
Not Just Another Limited Area Motion Detector!

guardex™

Protects Every Square Inch Of Your Building

Turns On Lights Automatically

Powerful Electronic Siren



The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6¾" × 9¾" × 8") and weighs less than 6½ pounds.

Low Cost Computerized Burglar Alarm System Home - Office - Business

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make several simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss...your roof, walls and floors.

HOW CAN ONE SMALL COMPUTER PROTECT MY WHOLE BUILDING?

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.

The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for $24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only $199.95. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of $199.95. If you want the optional outside siren, add $24.94. (California residents add 6% sales tax.)

(If you require more information, call during California business hours, Monday - Friday)

VISA

master charge

Dealer Inquiries Invited

CALL TOLL FREE
(800) 423-5499 Ext. 80

California residents:
(213) 889-1414 collect.

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Sears has a water heater that's so energy efficient it could save you $313 in gas bills over the next 10 years.*

Sears Kenmore Power Miser™ "120"
Water Heater saves an average of $313.05 on gas bills or $426.57 on electric bills over 10 years*
(when compared with our standard 40-gal. gas and 52-gal. electric models).

What makes these savings possible are the most energy-efficient water heaters Sears has ever offered.

Set it and save.
The Power Miser "120" gas model, for example, has a factory-calibrated energy saving setting that holds temperatures to the lowest recommended levels for appliances using hot water And a low-input pilot uses one-third less Btu's per hour than standard pilots do.

175% more insulation effectiveness.
The insulation is 1-inch thick, injected polyurethane foam. It's 175% more effective than the fiber glass insulation in our standard models.

Call on Sears to arrange professional installation. Ask us now for a FREE estimate.

Need a new water heater fast? Ask for Sears 24-hour Weekday Emergency Service.
You can depend on Sears to arrange fast installation of most of our water heater models. (Sorry, but emergency replacement isn't available on weekends or holidays.) And you know we'll stand behind the heater and the installation. What's more, you can buy everything on one of Sears convenient credit plans.

**In accordance with U.S. Dept of Energy Test Procedures, the operating cost was calculated on the basis of 64.3 gallons per day of hot water usage (90°F temp. rise) with gas rate of 36.7¢ per therm and electricity rate of 4.97¢ per kilowatt hour (U.S. government national average cost figures). Savings were calculated by comparing the operating cost of our standard 40-gal. gas and 52-gal. electric water heaters with the cost of operating the Power Miser "120" 40-gal. gas and 52-gal. electric models. Savings may be more or less depending on your hot water usage and local utility rates.*

You can trust your house to

Sears

Where America shops for Value

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MONTHLY®

The What's New magazine

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PS READERS TALK BACK

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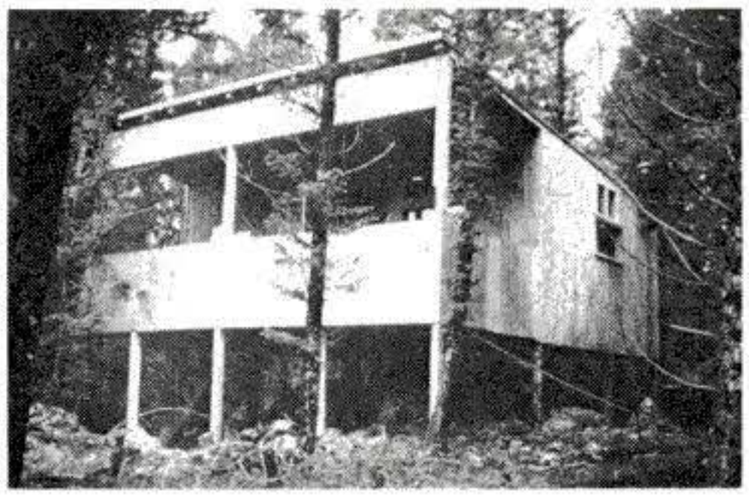
PS box-beam house



Here is a picture of our box-beam cabin that we recently completed. The design was from a POPULAR SCIENCE article, "Stacked Box Beams: Super-Strong Way to Build," in the August '73 issue. The construction was especially designed for irregular terrain, which just happened to match our remote site in western Montana. Although the building was done from the drawings, not a blueprint, it went exactly according to author Jackson Hand's description. We added extra support pilings underneath. It held six-foot-deep snow on the roof while unattended last winter, with no apparent harm.

From our experience, we might advise others to consider "prefabbing" the box beams before hauling them to the site. This was our first big project in 15 years of reading POPULAR SCIENCE and we're very pleased with the results. Thank you for such an excellent magazine.

Dr. Frank Mellblom, Cheyenne, Wyo.

Einstein passes plumb-bob test

I would like to clarify a point raised by Mr. Roger Ingalls in his letter [RTB, March] on the subject of the "principle of equivalence," discussed in your December '79 article "After 63 Years, Why Are They Still Testing Einstein?" Mr. Ingalls postulates that gravity and acceleration are not equivalent and uses the argument that a plumb bob hanging at the equator would make an angle of 90 degrees with one hanging at the North Pole, whereas in an accelerating elevator the plumb bob will only point down.

This is an invalid proof. Both gravity and acceleration are vector quantities, meaning they consist of a force and the direction in which the force is acting. The basis of Mr. Ingalls's argument is that gravity can act in a number of directions (depending upon where on Earth it is checked), whereas acceleration can act in only one. Dr. Einstein was not comparing the direction, but only the force of the two vector quantities. To make the comparison easier to visualize, gravity and acceleration should be compared where the directions can be ignored—such as in the same place. *Locally,* there is no test that can tell the difference, as your December article states.

More information on some of Einstein's theories can be obtained in George Gamow's delightful Mr. Tompkins stories, collected in *Mr. Tompkins in Paperback* (Cambridge University Press, New York, 1967). This is a thin book, well worth reading. Perhaps it can clear up some of the widespread confusion surrounding Einstein's work.

Bruce Fielder, Edmonton, Alberta

. . . The apparent dilemma concerning the nonconvergence of accelerational direction can be dissolved if we consider a balloon whose surface is accelerating outward uniformly and in all directions. In this case the acceleration vectors will converge on the center of the sphere. The original problem arose by comparing gravity and acceleration in different geometrical dimensions—planar (one-dimensional) and spherical (three-dimensional). The two conditions are equivalent only when we consider an infinitely small area of a spherical surface. Hence, we see that Einstein has withstood yet another test.

Jeff Gabbert, Cincinnati, Ohio

. . . and so do builders

I take exception to a sentence in Mr. Ingalls's letter that states: "Contrary to the assumptions of our building contractors, plumb bobs hung from various points above the Earth are not parallel."

[*Continued on page 155*]

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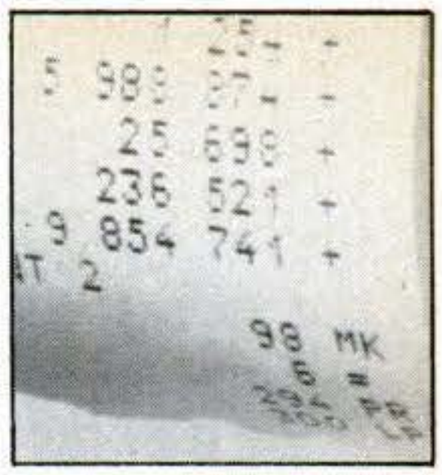
Olivetti Break-through

The world's smallest electronic printer will never run out of paper, ink or batteries thanks to Olivetti, JS&A and some incredible new technology.



The new pocket-sized Olivetti calculator slides open to unveil one of the most advanced printing heads ever developed.

It's a major breakthrough. That calculator shown above is the most advanced printing calculator in the world.

SLIP TOP PRINTER

The new Olivetti Logos 9 is only 1" x 2½" x 4⅝"—smaller than many cigarette packages. It has a full 12-digit liquid crystal display with add mode and full-floating or fixed position decimal.

To turn the unit into a printer, you simply slide up the top of the unit to expose the world's smallest and one of the most precise printing heads. The printing head prints letters and numbers, identifies each entry and even clearly separates groups of three whole numbers for easy readability.

PLENTY MORE

If its size and printing head are breakthroughs, so is its paper system. The paper is loaded in special cartridges with enough paper per cartridge for 1300 entries. All you do is simply pop a cartridge into the bottom of the unit each time you change rolls. It's the most convenient way ever designed to change a roll of paper for a printing calculator.

But if you're like most Americans, you'd be concerned about paper supply. Where do you get those special cartridges, and how do you know if you can get them years from now?

That's where JS&A comes in. A 32-roll supply—all you'll ever need for three full years—is only $16. That's enough paper for 41,000 entries or approximately 52 line entries each working day for three full years.

But even more important, within one year stationery stores will stock the cartridges, and we predict that the Olivetti cartridge will become a standard in the industry.

NO INK CARTRIDGES

The paper is a new type that looks exactly like conventional paper. But the paper, when struck, leaves a clear sharp image without the use of ink. So there's no messy cartridge required and no space needed to store one. You'll never need ink again.

The rechargeable batteries last for 8,000 lines when you use just the printer and 80 hours using just the liquid crystal display. The batteries can be recharged 500 times, so theoretically the batteries should last for 300 rolls of paper, or more than nine times the life of your paper supply. The batteries can also be easily replaced.

POWERFUL COMPUTER

The features looked great. The world's smallest size, the paper roll convenience, the no-ink system, the battery life and the large 12-digit liquid crystal display were enough to convince us, but would the new Olivetti be considered a toy? Then we learned about its computational power and features which we feel are better than many of the most professional full-featured printing calculators.

Speed It's the world's fastest small printer with a speed of 2.1 lines per second. The unit also has a buffer so if you enter data faster than the unit, it will still print out each entry.

Memories The Logos 9 has two separate memories. One is an accumulating memory, and the other is a fully independent memory. And the display and printer indicate which memory is on the paper tape.

Printing Head The totally new printing head is a semi-alpha numeric system which labels all entries with letters to indicate the entry. For example LP is list price and CNT means item count.

Clock The unit is so complete, Olivetti even threw in a digital clock function. Your unit will display accurate time when the 12-digit display is not in use.

Gross Margin It automatically computes everything from gross margins to discounts and retail pricing. You just enter your percentage mark-ups in its memory, and it will automatically compute the results while retaining the formula and percentage in memory.

Plus More It has automatic round off, letting you select which figure to round off to. You can add a column of figures and then average your calculations automatically. The full-information liquid crystal display will tell you everything from when you're in the printer mode to whether you have something in memory and in which memory.

The technological breakthroughs in the Logos 9 were possible because Olivetti was able to eliminate the many interface components between the integrated circuit and the printing head. This was all made possible because Olivetti designed the entire system, not just a few of the components as is the case with most calculators.

So there it was. Great features, great convenience and great value for only $89.95 complete with batteries, charger and 90-day limited warranty. For $16 more, you can get 32 cartridges—all the paper you'll ever need for three years or for $10 more you can get 16 cartridges. So impresed are we with the Olivetti Logos 9 that we are making the following offer:

FREE TRIAL OFFER

We urge you to test the Olivetti Logos 9 now. Order one for our 30-day no obligation trial. See the clear and easy-to-read paper tape and display. Use it as a pocket calculator, and carry it in your briefcase wherever you go. Experience the convenience of always having a printing calculator there whenever you need a permanent record of your transactions.

After 30-days of actual use, decide if you want to keep it. If you do you'll own the smallest, most advanced and convenient pocket printing calculator in the world. If for any reason you're not completely satisfied, simply return your unit within 30-days for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose.

Olivetti selected JS&A to exclusively introduce this exciting new product. With its solid-state design and high quality printing mechanism, the Olivetti should not require service. But if service is ever required, Olivetti maintains a convenient service-by-mail center as close as your mailbox.

To order your unit for our trial, simply send your money order or personal check for **$89.95** plus $2.50 for postage and handling (personal check orders, allow 20 days to clear our bank) to the address below, or credit card buyers may call our toll-free number below. Add $16 for 32 paper cartridges or $10 for 16 cartridges. (Illinois residents please add 6% sales tax.)

Who would have imagined a printing calculator this small and this convenient with this much computational power just a few months ago? The Olivetti Logos 9 deserves your test. Order one at no obligation, today.

JS&A PRODUCTS THAT THINK ®

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ETHANOL CHEMURGY CORPORATION
RELEASES IMPORTANT INFORMATION

HOW TO RUN YOUR AUTOMOBILE ON ALCOHOL FOR 10¢ TO 20¢ PER GALLON.

Energy News

Did you know that:

- Nearly everyone can, with the proper permits, manufacture their own alcohol as a fuel.
- You can immediately run your car on alcohol with no major adaptations.
- You can produce alcohol fuel for a cost of 10¢ to 20¢ per gallon and up.
- Alcohol is an anti-knock agent.
- Engines run smoother with no crank case dilution.
- You do not have to pay $1.00 per gallon to run your present automobile.

Instructions are available on how to build your own backyard still, providing you receive the necessary permits prior to constructing the still. The projected cost is around $100 to $150 and the still should produce 10 to 20 gallons per day.

For more than fifty years countless individuals have produced alcohol and used it as a fuel for internal combustion engines. These engines have worked superbly. Here are just a few of the many advantages of using alcohol as a fuel:

Using alcohol, an engine will develop 30 percent more power. Engine operation is smoother, and alcohol lets your engine operate under heavy loads and low speeds without "bucking." Alcohol also serves to loosen carbon accumulations.

Alcohol can be produced in a SOLAR STILL from grains, sugar beets, molasses, lawn clippings, weeds, sawmill waste, vegetables, fruits, etc.

For a limited time, Ethanol Chemurgy Corporation will send to all interested individuals: (1) A copy of their findings on alcohol as a fuel for internal combustion engines, (2) Instructions on where to apply for a permit to manufacture your own alcohol as a fuel, (3) Complete schematic drawings and instructions on how to build an inexpensive SOLAR STILL that you can put together in one afternoon, (4) A list of materials needed for the SOLAR STILL with approximate costs, (5) Basic recipe for producing your own alcohol fuel, and (6) Information where you can obtain more literature on alcohol as a fuel.

To obtain this information, mail the attached order blank with a check or money order for $9.95 payable to Ethanol Chemurgy Corporation. We will bill through your VISA or MasterCharge account if you prefer. Or, call toll-free 1/800/528-6050, Extension 1020, and your order will be processed within 12 hours. Please have your VISA or Master Charge handy when you call. This information carries a 30-day 100% money-back guarantee.

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Ethanol Chemurgy Corp.
Dept. P-6 • P.O. Box 220
Orem, Utah 84057

I'm enclosing $9.95 check or money order. Please rush me the alcohol fuel information described above.

Name _____

Address _____

City/State/Zip _____

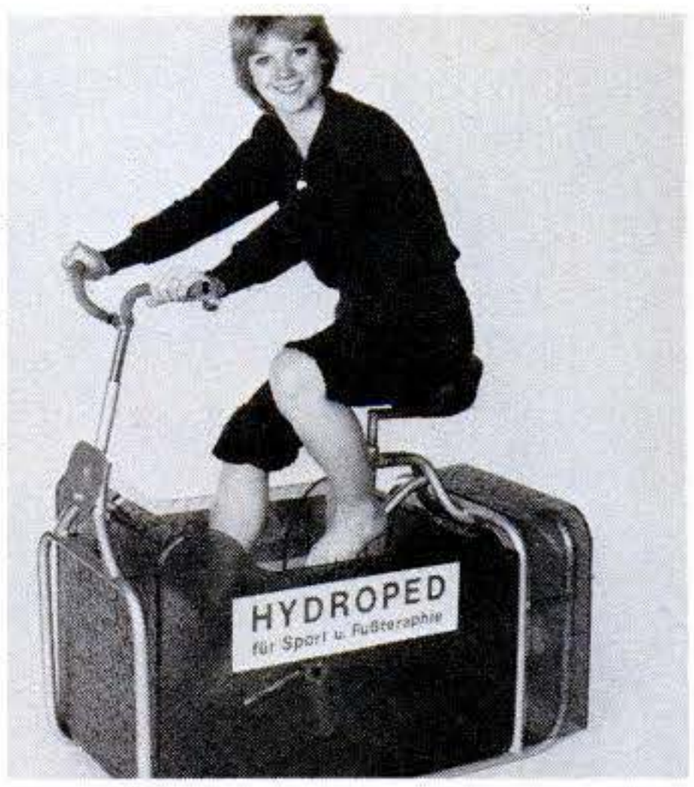
Please charge my order to VISA or MasterCharge

_____
Account Number

_____
Expiration Date

_____
Holder's Signature

Water bike
for frazzled feet

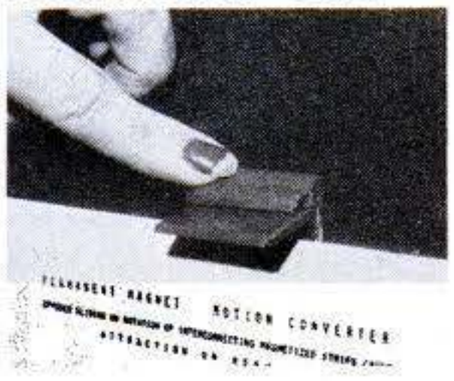


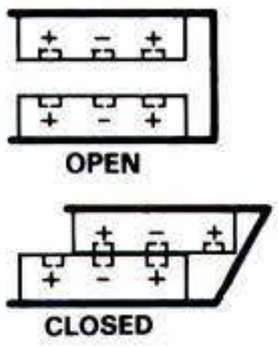
Jaded joggers might welcome a turn on this watercycle. It gives a good workout while soothing tired feet. Brisk pedaling spins a pair of propellers on the pedal crankshaft. The props churn up the water in the plastic tank, splashing the rider's feet with a heated, medicated bath. A submerged thermostat keeps the water at 38 degrees C (100 F), but adjusting an exterior dial can raise or lower this setting slightly. Controls, heater, and water pump are safely mounted in the tubular frame behind the tank. According to the inventor, Georg Leide (Jahnstrasse 41, 8751 Sulzbach, Main, Germany), the hydrotherapeutic bike eases joint, muscle, and circulation problems.—*David Scott*

Springless clamp

A gentle forward shove on this wall clip snaps it open; a rearward nudge clamps it tightly shut. Magnets, not springs, make it work. Both the sliding top pad and the rigid bottom one have three alternately polarized strip magnets (see illustration). Aligning the pads mates like magnetic poles, which repel each other to open the clip. Pushing the pad back aligns unlike poles, and the clip clamps shut.

Sets of alternately polarized strip magnets could be used on self-sealing box lids that would open by sliding or rotating, suggests the inventor (Dr. Hans-Georg Hutter, Beckgasse 46, 1130 Vienna, Austria). Other possible uses are snap-action, springless electric switches.—*D.S.*





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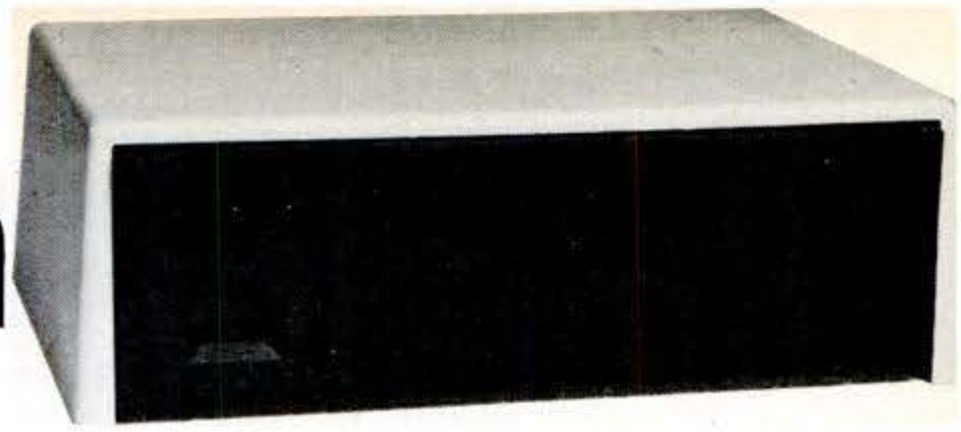
Burglar Alarm Breakthrough



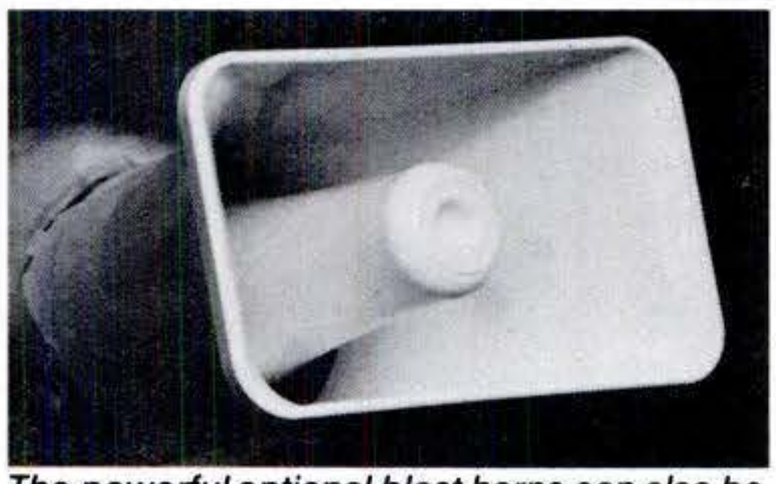
A new computerized burglar alarm requires no installation and protects your home or business like a thousand dollar professional system.

The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

It's a security system computer. You can now protect everything–windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain–loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity–just motion–and since a computer interprets the nature of the motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

ARRIVE HOME SAFE

There's personal danger in arriving home and finding a burglary in progress. And, if you surprise the burglar, you risk the chance of serious injury. With the Midex 55 protecting your home, you can open your front door with the confidence of knowing that no burglar lurks inside.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault should you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional features, the Midex system is complete, designed to protect you, your home and property just as it arrives in its well-protected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.–a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over $5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms–two of the top criteria used to evaluate these systems. Don't be confused. There is no system under $1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade–further assurance that your investment is well protected.

To order your system, simply send your check in the amount of **$199.95** (Illinois residents add 5% sales tax) to the address shown below. Credit card buyers may call our toll-free number below. There are no postage and handling charges. By return mail you will receive your system complete with all connections, easy to understand instructions and a one year limited warranty. If you do not have stereo speakers, you may order the optional blast horns at **$39.95** each, and we recommend the purchase of two.

With the Midex 55, JS&A brings you: 1) A system built with such high quality that it complies with the same strict government standards used in the space program, 2) A system so advanced that it uses a computer to determine unauthorized entry, and 3) A way to buy the system, in complete confidence, without even being penalized for postage and handling charges if it's not exactly what you want. We couldn't provide you with a better opportunity to own a security system than right now.

Space-age technology has produced the ultimate personal security computer. Order your Midex 55 at no obligation, today.

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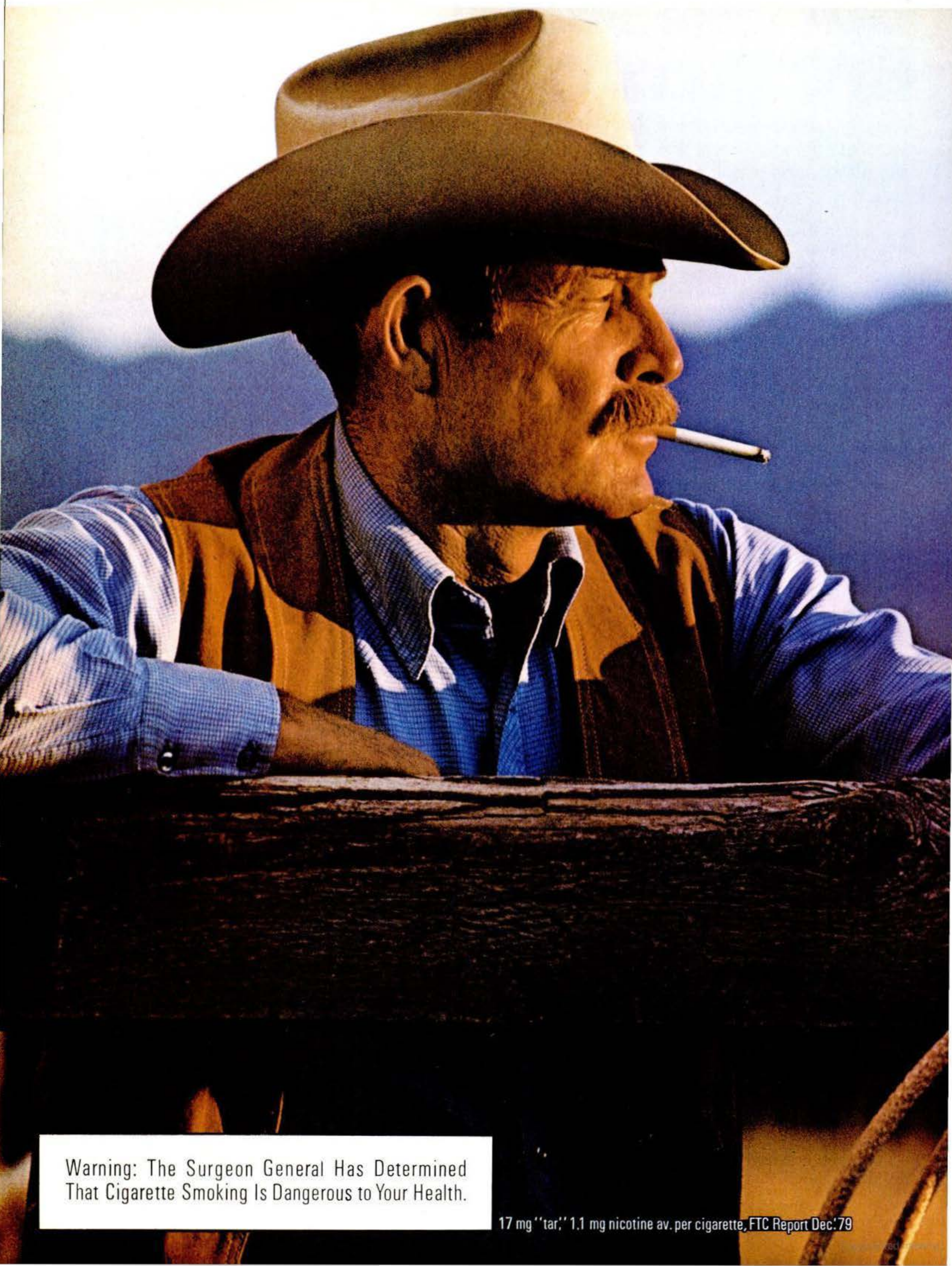

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

17 mg "tar," 1.1 mg nicotine av. per cigarette, FTC Report Dec.'79

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Marlboro Red or Longhorn 100's—
you get a lot to like.

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4WD mini-truck is tough off the road

Churning headlong into a sea of thick, sticky mud at Southern California's Saddleback Motor Park, Datsun's new four-wheel-drive pickup sank past its hubs with barely a trace of momentum loss. Now the mud started to win, and my forward speed slipped slowly under 10 mph until I dropped out of third gear. Then, like a strong plow horse catching its second wind, the Datsun 4×4 caught second gear and pushed through the mire onto higher ground.

For the next several hours, I put the new 4×4 through a grueling series of runs up and down trails, over steep humps, across cracks and crevices, and over torturous bumps. It was an impressive excursion.

The new 4WD is powered by a 90-hp two-liter overhead-cam engine. Three configurations—short bed, long bed, and King Cab—are offered. All have independent front suspension. Four-speed transmissions are standard in the short- and long-bed models with a five-speed overdrive in the King Cab.

The four-wheel drive is engaged by raising a detent lever between the bucket seats and by locking the front hubs. A high-speed detent is used for ice, snow, sand, mud, and most inclines. The low-speed setting throws added power to the drive shafts for getting through heavy snow or mud, tackling steep hills, and trekking those bone-jarring trails. Speed is placarded at 30 mph in the low setting.

In redesigning the truck line for the 4×4 models, Datsun increased ground clearance to more than eight inches. The vehicle has a crawl speed of just 1.3 mph, slow enough to creep through grasping muck.

In three days of running the 4×4 on and off Southern California roads, I found the ride generally smooth and quiet. But steering pressures were higher than comfortable. A full day piloting the truck through rough terrain is apt to leave many drivers with sore shoulders. Yet it never failed to respond to conditions, ranging from freeway passing to deep mud holes.—*Jim Schefter*

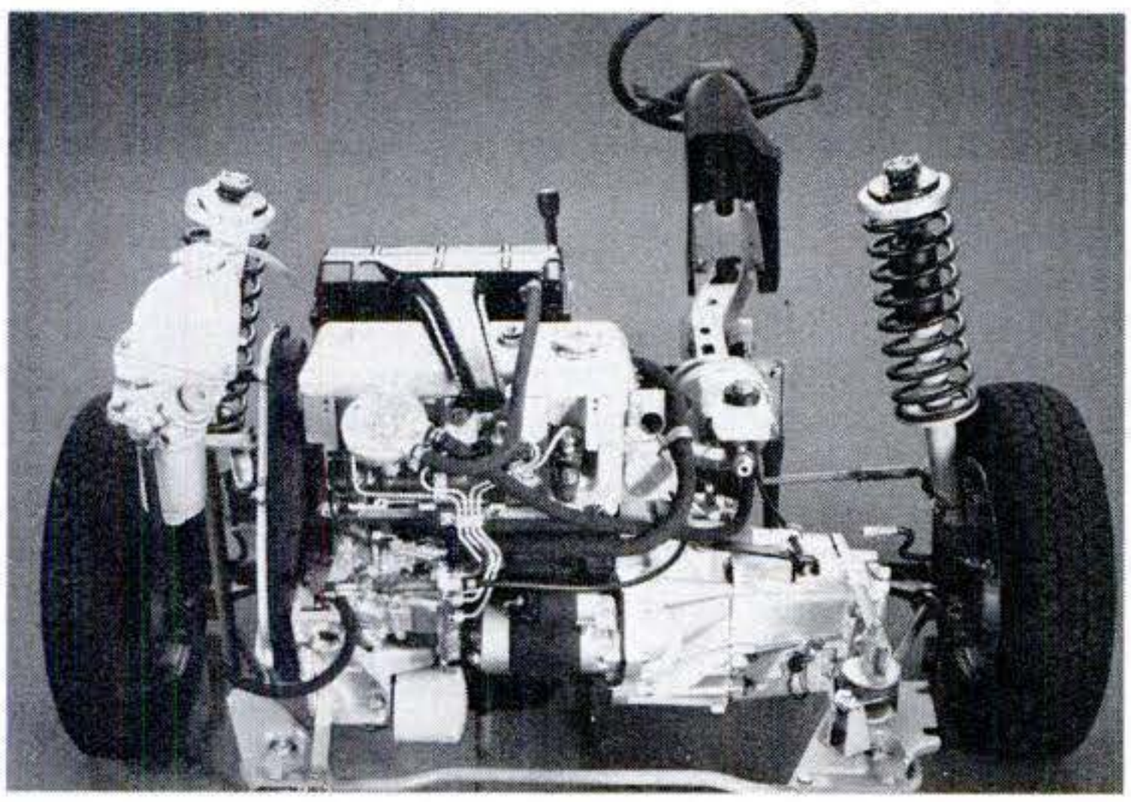
Diesel subcompact is a quiet performer

For fuel economy a diesel car can sure beat a gas-engined one, but can it match it in snappy performance and noise levels? Fiat's diesel Strada perhaps comes the closest yet.

I drove one around a 100-mile test route outside Rome, and was really surprised at the throttle response. My zero-60-mph time was 19.2 seconds, only two seconds slower than the comparable 1.3-liter gasoline version. Against this, the diesel VW Rabbit's figure is 22 seconds.

The 1.7-liter 55-hp is larger than the Rabbit's diesel. More important is its higher torque, which gives nimbleness in traffic and remarkable lugging ability at low revs. A five-speed gearbox is standard, and I found I could actually pull away smoothly from a 14-mph crawl in overdrive fifth. On a looping turnpike feeder road I accelerated up the gentle slope in this top gear from a 25-mph approach. The car then wound up to an 87-mph maximum, when the governor cut off the fuel at 4650 rpm.

Fiat has effectively silenced the diesel so you can barely tell it from a gasburner except when idling, and then only from outside the car. Fiat hasn't announced introduction into the U.S. yet.—*David Scott*



Husky 55-hp diesel has one-piece aluminum cylinder head that stiffens block to cut noise. Front suspension is shown here.

European Editor David Scott tested diesel Strada on Italian roads and was impressed by its nimbleness and quiet performance.

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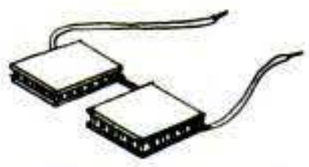
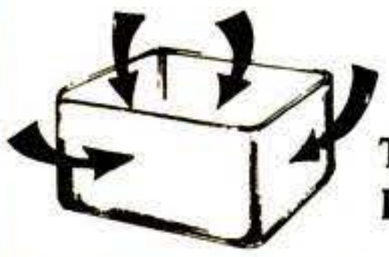
PORTABLE SOLID-STATE REFRIGERATOR



RELIABLE thermo-electric chips eliminate mechanical worries...the only moving part is a small fan, giving durable, maintenance-free operation.



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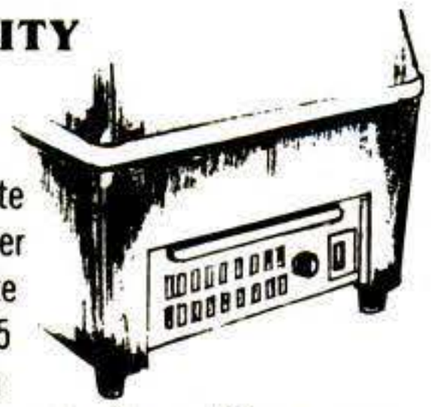
MAGIC TEMP's® exclusive **aluminum interior** acts as a thermal conductor making the entire liner a wrap-around cooling plate and eliminating 'hot spots' found in plastic liners.

ADD VERSATILITY



A **built-in converter** makes it possible to operate **anywhere** on either a 12 volt cigarette lighter or any 115 volt outlet with a simple switch of cords. No need for a power adapter...the total weight of the unit is only 14 pounds. Cools to 25°F (approx.) and heats to 140°F (approx.)

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RELIABILITY + WRAP-AROUND COOLING + VERSATILITY + DURABILITY

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Graphics tablet

helps you create computerized TV images

Logic symbols on TV screen are selected from menu (bottom) and moved around with electronic pen on Talos tablet. Tablet top is "mapped" in Apple's memory.

Home computers can create fascinating TV pictures, from realistic chess pieces and maps to animated bowling alleys or aircraft flights. But experts may spend days writing programs to create these images. I've just built a graphics tablet that simplifies creating computerized TV images by enabling me to draw them. The $499 Digi-Kit-izer from Talos Systems, Inc. (7419 E. Helm Dr., Scottsdale, Ariz. 85260), goes together in a few evenings of work.

As I move a special pen over the 11-by-11-in. tablet surface, I can "draw" in the memory of an Apple II computer. These memory changes become a TV picture. Beneath the tablet's blue plastic cover is a printed circuit board with a grid of electronically scanned conductors. A small coil in the pen tip, driven at 102.4 kHz, induces signals in the conductors. Detector and digital circuits can then fix the pen's location. An interface circuit feeds this information to a computer. Talos has circuits for the Apple ($99), Radio Shack TRS-80, and RS232 hookups (most computers).

How can an Apple use this pen-location data? One Talos BASIC program lets you "paint" color TV pictures. A row of color blocks appears at the bottom of the screen. You select background and painting colors simply by pressing the pen tip on blocks. This operates a pen switch, telling the computer the colors chosen. The BASIC program makes a tiny block of color "float" around on the TV screen, tracking pen movements. Just press the pen down to paint. The colors are dazzling, but the blocks are too coarse (40-by-40 screen resolution) for much artistry.

High-resolution programs in the Talos $50 Super Graphics package are more useful. Realistic line drawings are possible with the Apple's 280-by-192 resolution. A computer-aided design program (photo) is included, along with programs to compute the area in a polygon or the distance between points.

Creating your own programs can make the tablet useful for design, engineering, mapping, and scientific work. A medical specialist I met uses his for X-ray analysis. I'm linking the tablet to a remarkable high-speed 3D-graphics program from Sublogic (Box V, Savoy, Ill. 61874). It, among other things, lets you create objects in space, then "orbit" around them.—*John Free*

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a $5. 3 way shower massage?

Try 10 DAK high energy 90 minute cassettes risk free for only $2.19 each and get a pulsating $29 value shower massage for only $5.

It's your choice. Think about the kind of music you like. You don't want to think about cassettes jamming, loss of high frequency response or tape hiss.

DAK manufactures a cassette that you can really forget about. Great sound, and no problems. And, for only $5 we hope you will think a lot about your new pulsating 3 way shower massage.

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

MOLYSULFIDE

DAK manufactures enough tape for over one million cassettes per month. We developed polyester slip sheets, inside the cassette, with raised spring loaded ridges to guide each layer of tape as it winds. We coat them with a unique formulation of graphite and a new chemical called molysulfide.

Molysulfide reduces friction several times better than graphite and allows the tape to move more freely within the cassette.

Hi frequency protection! Friction within the cassette causes the build up of static electricity, (much as scuffing your shoes on a carpet in dry weather), which can erase high notes. Molysulfide reduces friction which is a very important consideration for often played tapes.

MAXELL IS BETTER

Yes, honestly, if you own a $1000 cassette deck like a Nakamichi, the frequency responses of Maxell UDXL or TDK SA are superior and you just might be able to hear the difference.

DAK ML has a frequency response that is flat from 40hz to 14,500hz ±3db

Virtually all cassette decks priced under $600 are flat ±3db from 40hz to about 12,500hz, so we have over 2000hz to spare, and you'll probably never hear the difference.

No apology. We feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes and offer one of the best frequency responses in the industry. Maxell UDXL is truly the Rolls Royce of the industry, and DAK is comparable to the 100% US made Cadillac or Corvette!.

Price. DAK manufactures the tape we sell. You avoid paying the wholesaler and retailer profits. While Maxell UDXL 90s may sell for $3.50 to $4.50 each at retail, DAK ML90s sell factory direct to you for only $2.19 each complete with deluxe boxes and index insert cards.

A 3 WAY $5 SHOWER MASSAGE?

You'll be living in luxury. This powerful 3 way shower massage will massage and relax your tired muscles. You can use its powerful massaging action directly from its standard wall mount, or hold it in your hand and direct the spray exactly where you want it.

The shower massage has a three position power control: 1) it has a normal full spray like a shower head, 2) a combination of normal spray and gentle massaging action, and 3) full massage to relax your total body.

It comes off the wall. This hand held shower massage has a nearly 5 foot flexible chrome plated hose that allows you freedom of movement. You can direct the spray from any angle or height that you desire. To remove the hand unit from its wall mount, simply lift and turn. It's easy for all family members.

EASY INSTALLATION

No plumber, no problems. Simply unscrew your old shower head, and screw in this deluxe massage. The wall mount is incorporated into the main unit and requires no installation. This fine shower massage even has its own built in filter screen, and there is no maintenance required. Just relax and enjoy.

The hand unit is approximately 9 inches long, and the massage section is 3 inches in diameter.

DAK TAKES A RISK

Obviously giving away quality shower massages is not going to make DAK rich. We are betting that you will buy our cassettes again, and we are putting our money where our mouth is!

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and 4500 repeat customers from this ad to add to our list of over 70,000 actives.

TRY DAK ML90 CASSETTES FREE

Try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, simply return the tapes and shower massage for a full refund.

To order your 10 DAK ML 90 minute high energy cassettes at $2.19 each and the $29 value shower massage with your credit card, simply call the toll free number below, or send your check for **$21.90** plus **$5** for the shower massage and **$3** for postage & handling for each group of 10 cassettes to DAK.
(CA residents please add 6% sales tax)

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette to each extra 10 you buy and of course you can buy one $29 value massage for $5 with each group you buy.

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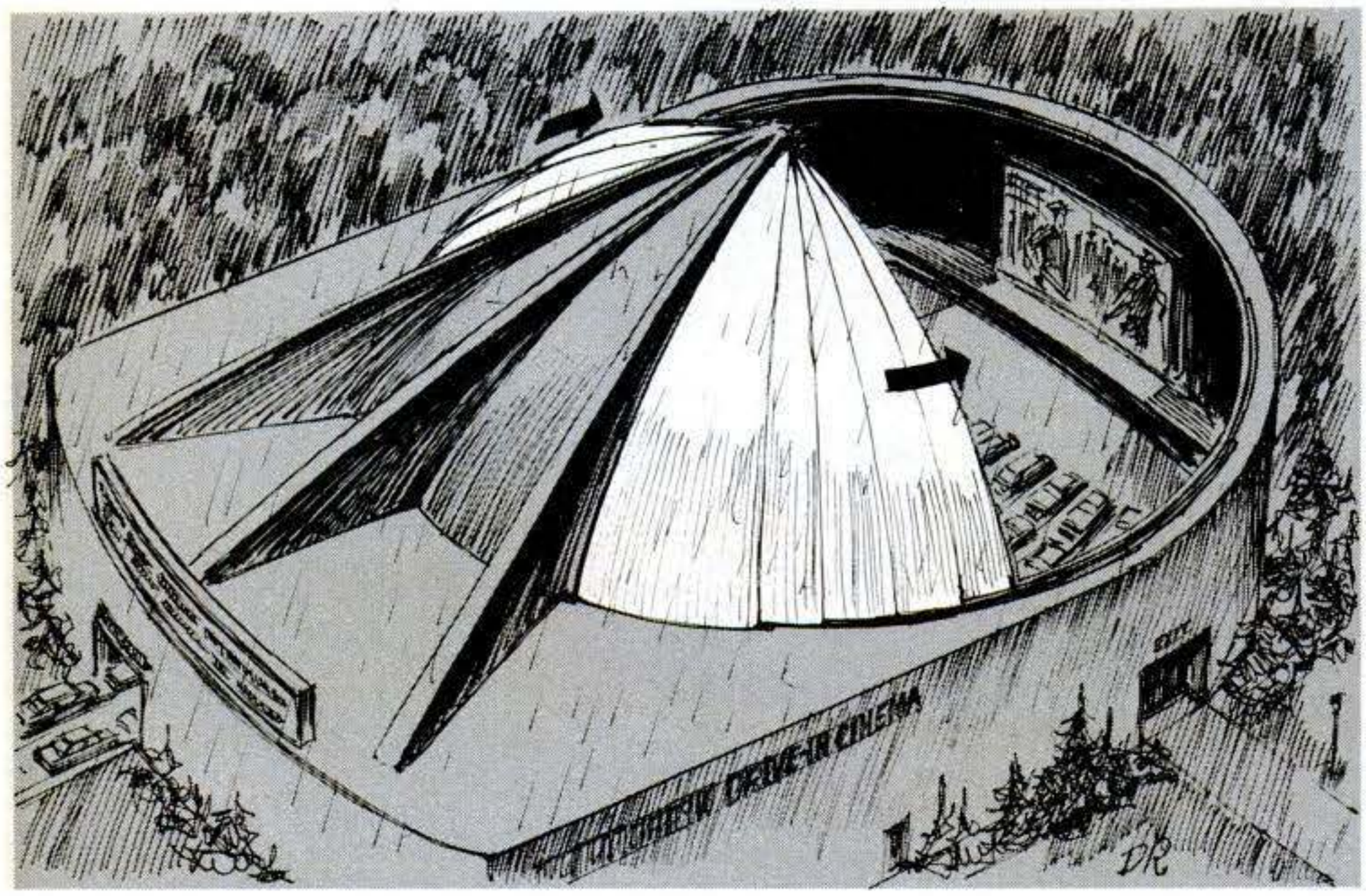
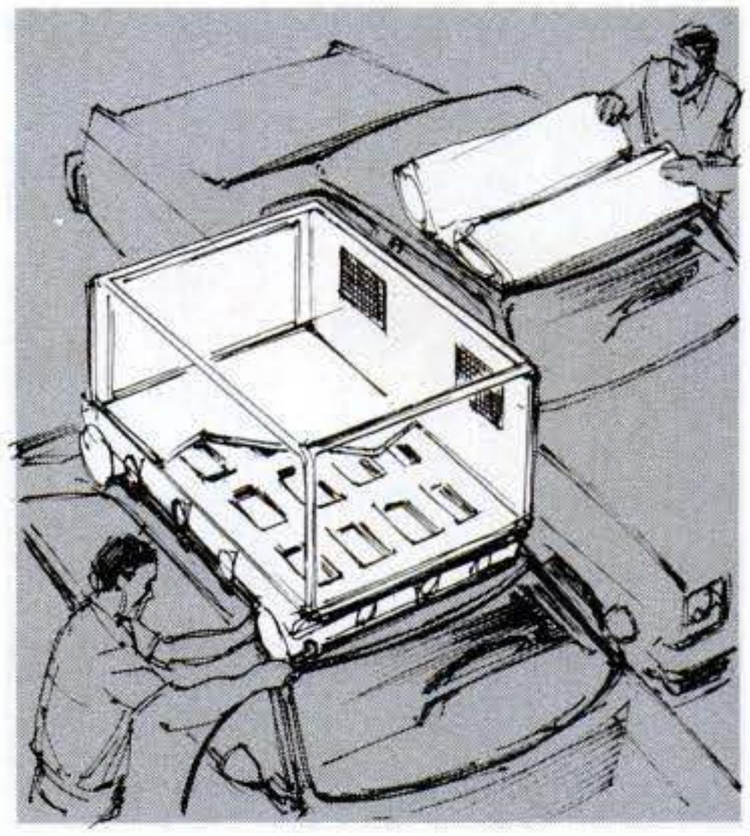
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY DANA RASMUSSEN



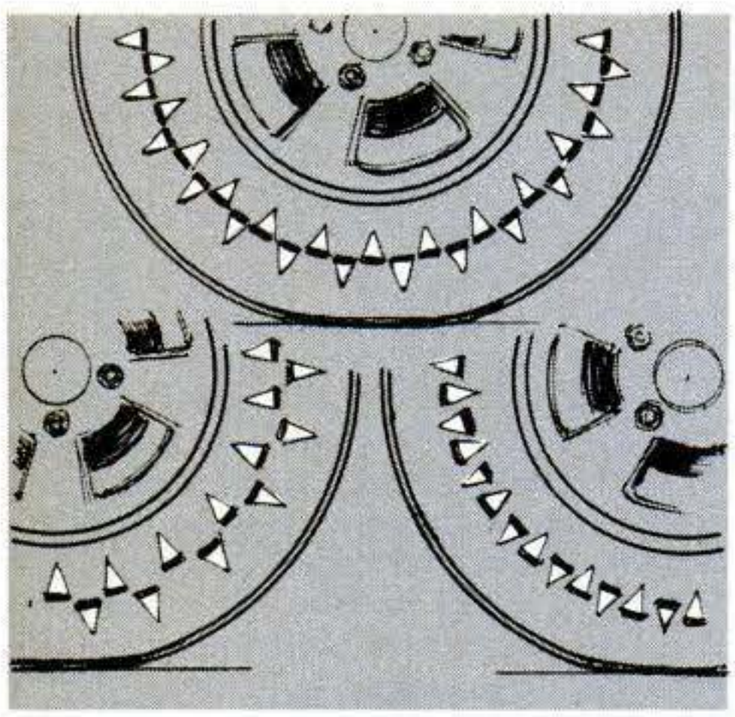
Folding dome stretches drive-in's hours and uses

Wedge-shape panels in the dome section of this theater roof could be opened on pleasant nights so patrons in cars could view a movie as they would in a conventional drive-in. With the roof panels closed, the performance could start before dark or continue in bad weather. For live as well as film shows, chair seats might be provided around the parking area or in a balcony at the rear over the snack bar. Daytime patrons would drive in through light-shielded tunnels.



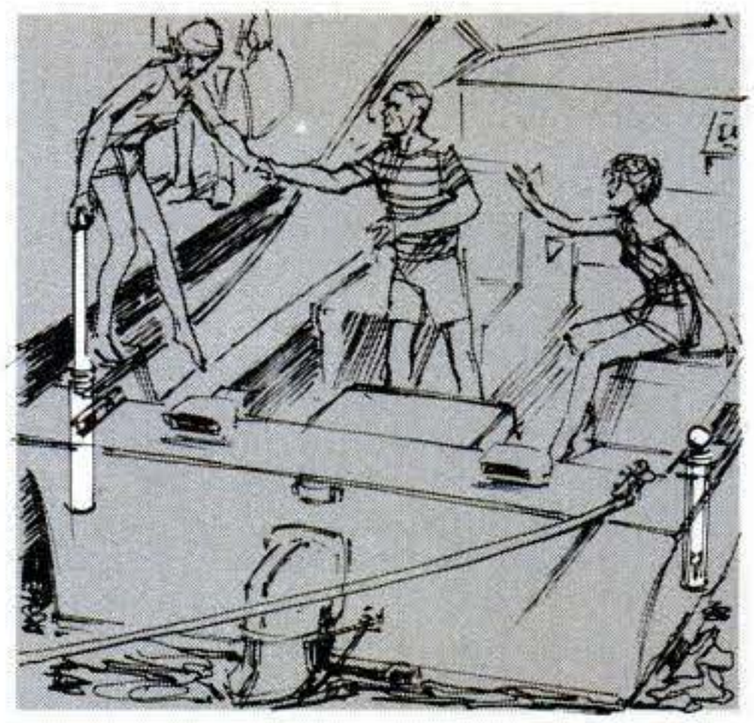
Carrier inflates for shelter

Rising from an inflatable, load-distributing mattress, the pairs of spaced-apart plastic sheets that form the sidewalls of this car-top carrier could be raised by pumping in air. It would provide needed—and adjustably snug—space for cargo. Deflated and lowered, it would travel easier, store compactly. Placed in a pickup bed or on the ground, the windowed, canopied shelter could also serve as a tent.



Sidewall marks check pressure

Molded into the sidewall of a tire around its centerline, these interfitting points would overlap when a tire was overinflated and separate (due to bulge) when pressure was low. Making it easier to check tire condition at a glance can be especially helpful with low-profile tires; it could also prolong tire life now that gas-station tire checks are becoming rare.



Handle eases boarding

Sliding up from a recessed to an extended position, this handle would let you steady yourself as you boarded or clambered off a small boat or cruiser. The outer portion of the telescoping-tube arrangement would be set into the gunwale; thumb-operated spring latches would lock the sliding rod in either its retracted or easy-to-grab raised position.

Roller brush finishes corners

Slipped into its socket on a paint-roller arm, this outboard brush could be adjusted to reach up to or just beyond the paint-applying surface of a conventional roller. It would let you brush-smooth roller-applied paint where that might be necessary, or continue a precise line into a corner or other butting surface where a roller can't normally reach.

The following patents have been issued on these inventions: **Daylight drive-in**—No. 4,075,795 to A. Thomas, Coatesville, Pa.; **Tire check**—No. 4,134,357 to G. Chesley, Los Altos, Calif.; **Boarding handle**—No. 4,074,379 to L. Grossman, Pompano Beach, Fla., J. Collins and E. Kohls, Milwaukee, Wis.; **Car-top shelter**—No. 4,101,062 to B. Lazar, Houston, Tex.; **Paint roller-brush**—No. 4,100,642 to Charles K. Gabor, Astoria, N.Y.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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It has economy written all over it.

The Volkswagen Pickup.

Probably one of the most economical pickups ever invented with a fuel-injected gas engine. And if you want even more economy there's a diesel option that delivers mileage no one can beat.

(It gets an EPA estimated 23 mpg, 32 mpg highway, estimated 39 mpg diesel and 48 mpg diesel highway. Use "estimated mpg" for comparisons. Your mileage may vary with weather, speed and trip length. Actual highway mileage will probably be less.)

But the engine's not the only thing that's economical.

It has front-wheel drive for economical power transfer from the engine to the wheels.

And, the engine is transverse-mounted for more economical use of cab space for passengers and better forward visibility for the driver.

What's more, it has an independently operating electric fan to cool the engine more economically, too.

In the back, it has double-wall construction so that if something you carry in its six-foot steel bed makes a dent on the inside, nothing shows on the outside. But the most economical thing of all about the Volkswagen Pickup is the fact that it's still a Volkswagen.

VOLKSWAGEN DOES IT AGAIN

©1980 VOLKSWAGEN OF AMERICA

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No compromise
Winston Lights didn't compromise
Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.
LIGHTS: 13 mg. "tar", 0.9 mg. nicotine, LIGHT 100's: 13 mg. "tar", 1.0 mg. nicotine, av. per cigarette, FTC Report MAY '78.

© 1979 R. J. Reynolds Tobacco Co.

oon great taste to get low tar. Why should I?

Winston Lights taste good like a light cigarette should.

Copyrighted

Six reasons to retire your old slide projector.

The longer you've been into slides, the more a new Kodak Carousel projector has to offer.

Upgrading your projector can upgrade your whole slide collection in one stroke! With our top-of-the-line Kodak Carousel projector, you not only get the reliability Carousel projectors have been famous for over the years, but the many improvements that have come along since.

- Sharp, Ektanar C curved-field lens. Both normal or zoom to choose from. For brighter images with improved edge-to-edge sharpness.
- Automatic focusing. Keeps the show in focus slide after slide.
- Remote control, both forward and reverse. Even remote-focus override. For easier, more comfortable showing and viewing.
- Programmed showing. So you can sit back and relax and let the projector advance the slides at 5-, 8-, or 15-second intervals.
- Transvue 140 tray. So you can pack in a lot more slides.
- Built-in dark shutter latch. So the screen stays dark when no slide is being shown.

With eleven Kodak Carousel projector models to choose from, you can get just what you want in the way of automation, and in the way of price.

1880 Kodak *1980*

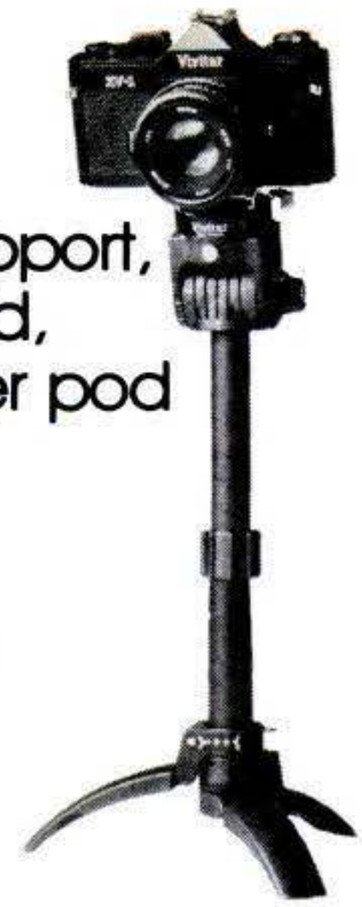
America's Storyteller

Kodak Carousel projectors.
The dependable ones.

© Eastman Kodak Company, 1980

14-oz. tripod

is a flash support, table-top aid, and shoulder pod



Pull up the head and twist the center lock, and this nine-inch tripod opens to its full height of 13¾ inches—only a 50 percent enlargement, but look what it does: Its three plastic legs, which fold flat against the body for compact storage, pull out, locking the shaft and making a stable support for table-top photography.

Or you can swing the legs around, one on top, two below, for a firm gunstock-type shoulder rest. The head swivels to any angle for shooting, or flops over 90 degrees for vertical-format pictures. It is stable even with quite heavy lenses.

Want to set up a dual-flash arrangement? Two slim metal arms hook into the head to become a secure perch for the flash units.

The Model 900 tripod is made in West Germany and distributed in the U.S. by Vivitar Corp. (1630 Stewart St., Santa Monica, Calif. 90406). It retails for $50. The arms are not included; they're priced at $11 each. —*Everett H. Ortner*

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Now! A Scientific Way to "SCRUB" the Air Clean!

Clear The Air with "NATURES-AIRE"

Makes dust, odor and pollutants vanish—leaves the air country fresh

listed by UL

Discover nature's own "secret" for fresh air...
Ever notice how wonderfully fresh and clean the air is after a good thunderstorm? Well, it wasn't the rain that cleansed the air... it was the negative ions generated by the storm. Now you bring that same natural phenomenon into your home, office or car with Natures-Aire, the ion generator that works like Mother Nature to cleanse, purify and refresh the air you breathe!

Natures-Aire—a controlled "thunderstorm"
That's right! Natures-Aire safely and electronically emits negative ions to create the same beneficial balance of ions found in the great outdoors—right in your home. You just plug it in and it silently and immediately begins to sweep unpleasant odors, smoke and pollutants from the air—leaves it refreshed and smelling sweet and country-fresh.

Unlike many similar products
Natures-Aire produces precisely the right balance of ions—25,000/cm3. Scientific research has shown that much more or less would not have the beneficial effect. In fact, Natures-Aire is now the *standard by which Underwriters Laboratories measures other negative ion generators*. It is the first ion generator to receive U.L. listing.

Negative Ions—Nature's "Good Guys"
Though you can't see them working, negative ions actually grab on to particles of dust, smoke, organic and inorganic pollutants and sweep them from the air. Just as negative ions cleanse the air after a thunderstorm, Natures-Aire cleanses the air in your home with its gentle, controlled stream of negative ions—Nature's "good guys".

Natures-Aire—no matter where you live
Studies show that winds carry harmful pollutants everywhere—even to tucked-away communities. That's why Natures-Aire is so vital for everyone. In the near future, negative ion generators will undoubtedly be standard equipment in airplanes, office and apartment buildings. But you don't have to wait! You can start protecting your whole family from harmful pollutants and unwanted odors right now with Natures-Aire.

Perfect when you entertain
You'll love breathing purified air everyday, but imagine what a great benefit Natures-Aire will be when you have parties. No lingering cooking odors to embarrass you—no smoke filled rooms when the guests are gone! Yes, Natures-Aire will actually destroy stubborn odors, smoke, dust and other harmful pollutants in the air—not just cover then up with an artificial "freshener." Lets the whole family breathe easier! Just think what an important difference it will make to your personal environment.

Proven safe and effective
Yes, Natures-Aire's graphite conductive fibers are so safe a baby could chew on them. And Natures-Aire sweeps any airborn micron-size pollutants from the air and deposits them in the wall or floor. *So effective at eliminating smoke and odors, you'll notice the pleasant difference in just minutes!*

Now—Mountain-Aire for your Car, Van, Truck or Boat
Natures-Aire has a "twin" that works wonders in your car, too. It's called Mountain-Aire. You just plug it into the cigarette lighter of your car and enjoy a smoke-free, odor-free, pollutant-free freshness wherever you go!

Put your nose to the test without risk!
You're probably a little skeptical. That's okay—we're so convinced that Natures-Aire and Mountain-Aire are the most effective, revolutionary air purifiers around that we're prepared to offer you a 30-Day Money-Back Guarantee. Prove it to yourself. Use Natures-Aire in your kitchen, bathroom, living room, bedroom (many say they actually sleep better!) and Mountain-Aire in your car and see for yourself if you don't notice the refreshing difference right away.

Small price—big reward!
You can own the product of the future for just $79.95. What a small price to pay for clean, invigorating air for years to come! But remember—if you're not absolutely convinced that Natures-Aire and Mountain-Aire far out-perform other air purifying systems, simply return your order for a prompt, courteous refund.

Pure air... Pure value!
Imagine! For fresh, pure air every day of your life—you pay just $79.95. *A small investment when it comes to protecting the well-being of your whole family!*

Safe enough for a baby... yet effective enough to rid your home of lingering smoke, odors and pollutants. Leaves it wonderfully refreshed and sweet smelling!

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☐ YES! Please rush me _____ (quantity) Natures-Aire Ion Generator(s) at just $79.95 plus $3.95 for shipping and handling. (Ill. residents add 6% sales tax.) I understand that if I am not absolutely satisfied with my purchase, I may reurn it within 30 days for a prompt and courteous refund.

☐ OPTION! Send me _____ (quantity) Mountain-Aire Ion Generator(s) for my car or van at just $79.95 plus $3.95 for shipping and handling.

☐ Check or MO enclosed
☐ Charge to: ☐ American Express ☐ Diners Club
☐ Carte Blanche ☐ Master Charge ☐ Visa

Account # _____ Exp. Date _____
Name _____
Address _____
City _____ State _____ Zip _____
Signature _____

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Travellin' Fridges

FROM ONLY $129.

Space age breakthrough creates a new line of Koolatron electronic portable refrigerators and food warmers.

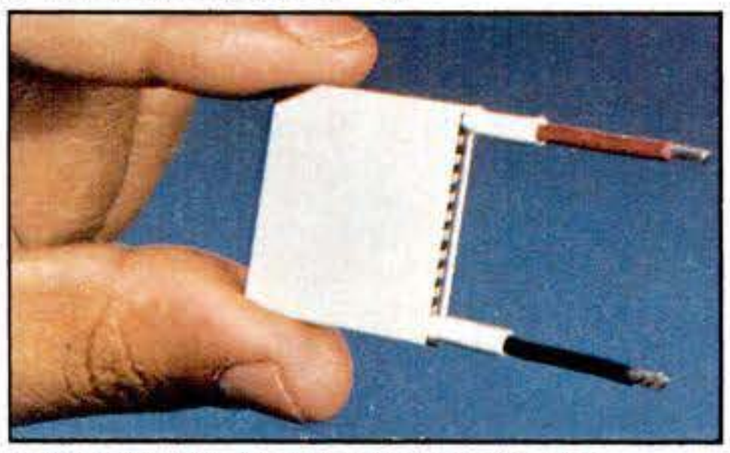
You've nicely gotten away on your long awaited vacation, camping trip or long weekend with the family. You're comfortably cruising in your car, van or rec. vehicle along a busy interstate with few rest stops or restaurants. You guessed it... the kids want to stop for a snack. But your Koolatron P34 or P34A is full of sandwiches, cold pop, fried chicken... home made, fresh and cold. The family helps themselves and you've saved valuable vacation time and another expensive restaurant bill.

You're a commuter, a salesman or a trucker and you spend many hours in your vehicle daily. You've often longed for a fresh snack or cold beverage as the miles tick away. Now with your amazing Koolatron P10 plugged in beside you, you open the lid and instantly fresh food and drinks are at your fingertips. You're refreshed... you've saved an unnecessary stop, time and money.

AFFORDABLE CONVENIENCE

Home refrigeration has come a long way since the days of the ice box and the block of ice. But most of us resign ourselves to doing without the same convenience once we leave our homes. Or, we revert back to the cooler and ice routine of days gone by, simply because there's never been any dependable and inexpensive alternative. But now, for the price of a good cooler and one or two seasons of buying ice, (or about 10 family restaurant meals), all the marvels of home refrigeration are available electronically. And the sloppy ice cooler with its soggy and spoiled food can become a stone-age memory for you. An amazing space-age miracle... the thermo-electric solid state module... makes this portable refrigeration revolution possible.

AEROSPACE MODULES



Two of these miniaturized thermoelectric modules replace all the bulky complex piping coils, compressors and motors in conventional portable refrigerators.

Utilized by NASA scientists, as the only refrigeration system for rockets and satellites, thermo-electric cooling has been in use for almost a quarter century. These expensive modules were selected by NASA for some basic reasons... they're small (about the size of your watch)... they're light weight (2 of them weigh less than a package of cigarettes)... they're totally reliable (these modules are completely solid state and have no moving parts)... they require little power (2 modules use the same power as one of your car's tail-lights)... they're completely insensitive to tilting, bumping, vibration, (which causes failures to conventional compressors, motors and piping)... they're powerful (2 modules have the same cooling power as a 10 lb. block of ice)... and they never wear out or break down. And for portable refrigeration where you require 12 volt DC. power, thermo-electric modules are the most efficient. These amazing heat pumps have not only gone to the moon, but have provided the breakthrough for Koolatron's truly reliable, lightweight portable refrigerators.

THOUSANDS IN USE

Koolatron Industries Limited now has tens of thousands of these electronic fridges in use worldwide using these same powerful solid state modules. The reliability, performance and convenience of electronic refrigeration has now been dramatically tested and proven in all kinds of temperatures, conditions and environments from Australia to Alaska. Built to take it, two of these electronic modules are encased in tough, plastic insulated chests that are designed to be rugged and trouble-free. Non-rusting hinges and latches prevent corrosion in salt water environments. And with only one moving part (a small 12 volt fan) Koolatron portables seldom see a service depot. Koolatron's combination of space-age heat pumps and quality engineering have now led to a whole family of electronic portable refrigerators and food warmers that eliminate costly ice and provide "home refrigeration" convenience at sane and sensible prices.

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MODEL P10 – THE PERFECT CAR FRIDGE & FOOD WARMER **$129.00 (in Canada $139.00)**

Holds approx. 17, 12oz. pop cans – refrigerates in air temps. up to 95°F. Also keeps hot foods hot (150°F.) at the flick of a switch. Deep rich blue Polypro plastic case. Ext. 16"L x 11"H x 11½"W. Int. 11½"L x8"H x 8"W. with 10 litre capacity (0.4 cu. ft.) weighs 10 lbs. empty. Operates from supplied 12 volt power cord in vehicles or with optional 12VDC/110VAC power adaptor.

Koolatron's P10 not only makes a great car fridge but at a flick of a switch lets you bring home your favourite fast foods "piping hot". Comes with a 9 ft. power cord that just plugs into your cigarette lighter. Amazingly easy to operate ... one switch selects hot or cold. A second switch allows you to refrigerate normally or select maximum cold. With your engine off, you can operate for up to 6 hours and still start your engine. "A low battery" indicator warns you when it's time to recharge. With the power off, your P10 keeps everything hot or cold for many hours in its well insulated case.

As a travel fridge the P10 keeps your favourite foods and beverages fresh and cold wherever you go. If you're a salesman, your food samples will arrive perfectly hot or cold every time. If you carry insulin, medical samples, dietetic foods, your P10 will never leave your side. Great for private planes.

Photographers will find it invaluable for keeping expensive films from going bad. And mothers ... now you can refrigerate baby's formula in your car then heat it with the flick of a switch or keep it cold. Powerboaters, just plug it into your boat's cigarette lighter, and keep a day's food and drink ice cold without running into shore for ice. You campers, hunters and fishermen will find endless uses for transporting provisions and bait ... then take home your catches and game without spoiling. Terrific for golf carts.

And with our optional 110 volt adaptor you'll find endless uses wherever house current is available ... At your cottage ... as a bar fridge ... in your motel room for a midnight snack and drink ... as a small office fridge ... or beside your pool. Use as an auxilliary home fridge when you're having a party. And it's a natural at drive-in movies, auto races and at sporting events.

MODEL P34 – THE PERFECT RECREATIONAL FRIDGE **$169.00 (in Canada $179.00)**

Holds over 40 lbs. of food and beverages or 48 pop cans. Refrigerates in air temperatures up to 95°F. Rugged ABS case in sand beige colour with dark brown non-corroding latches and handle. Large 34 litre capacity (1.2 cu. ft.) weighs 17 lbs. empty. Ext. 21"L x 16"H x 16"W. Int. 16"L x 12"H x 11½"W. Operates on 12 volts DC with supplied power cord or with optional 12VDC/110VAC power adaptor.

The P34 is the full-size member of the Koolatron family of portable electronic fridges. It is designed especially for the serious traveler and outsdoorsman. Newly designed for the 80's, this handsome improved portable will refrigerate more than 3 times the contents of the P10. As a hunter, camper, boater, you'll be amazed at the capacity and convenience.

Imagine dry, dependable refrigeration with the size to match your travelling and camping needs. Fits into any boat, van or camper or back seat of your car. Plugs into your cigarette lighter receptacle and refrigerates over 40 lbs. of food (no space wasted by ice), yet it draws no more power than the P10. With our optional 110 volt adaptor, you'll find endless uses as a bar fridge, cottage fridge, office fridge. Dazzle your friends at your next pool party with a full pay load of cold ones right beside the pool. Your P34 has all the advantages of the P10 without the heating cycle or low battery indicator but with all the capacity needed for serious boaters, campers, hunters, fishermen and travellers.

MODEL P34A – THE ULTIMATE RECREATIONAL REFRIGERATOR & FOOD WARMER **$189.00 (in Canada $199.00)**

The same size, colour, weight and capacity as the P34 but includes food warming features, fully adjustable temperature control and low battery warning indicator.

The P34A is our top of the line portable. It heats, it refrigerates and with specially designed electronic circuit control (patent applied for) it allows you to dial a complete range of temperatures from very cold to very warm.

READ WHAT OUR CUSTOMERS SAY:

"We took meat from Canada and ate it ten days later after thawing it in Florida. All our produce and drinks stayed unbelievably fresh and cool." S.H., Hamilton, Canada

"The way I try to sell my refrigerator one would think I was on commission. We love our unit!" P.O.P., Houston, Texas

"I am so pleased with the fridge I don't know how we got along before – it's so easy – to carry, use, maintain. For such a relatively small cost the convenience is inestimable." K.R., Ottawa, Canada

"The Koolatron is everything they say about it in its advertising. I personally bought one, tested it and found it so desirable that I gave it to my daughter and son-in-law who made a cross-country trek from Vermont to Oregon with their infant daughter. They told me that aside from their new Dodge van, the Koolatron was the most indispensable item of equipment they carried." K.M., New York, N.Y.

You wine buffs will find it indispensable to chill up to 1 doz. wine bottles at just the right temperature. Low battery indicator warns you when you need a recharge and the sensing circuits efficiently control your power consumption to save on battery drain. This is our best of the line, recreational fridge and food warmer with all the bells and whistles for the discerning buyer who demands quality, size and complete versatility.

ORDER TODAY WITHOUT OBLIGATION!

Simply complete the attached order form or phone collect and we'll rush you your portable on our no risk 21 day trial offer. Each unit comes with complete instructions and a written 1 year warranty. In the unlikely event you ever need service, we have major service centres in New York, Arizona and Canada. When you receive your Koolatron, use it constantly for 3 full weeks without risk.

If you ordered our optional 110 volt adaptor, plug it in, then use your portable immediately as a bar fridge or around the patio or pool. Next plug it into your car or RV. Take your family out for a weekend trip. Enjoy fresh home cooked food as you thumb your nose at those expensive restaurant stops. Then use it on your boat or in your office or let your son or daughter try it at their college dorm. If after you've thoroughly tested it, you don't agree that your Koolatron represents a major breakthrough that will save you time, money and bother for years to come, send it back for a full refund. You can't lose ... we guarantee it.

So be among the thousands to discover that the ice age is over! Don't waste another dollar on ice ... order your Koolatron with no obligation, today!

For rush delivery phone your order in collect to

0-705-737-0842

Koolatron Industries Limited
56 Harvester Ave., Batavia, New York 14020
230 Bayview Drive, Barrie, Ontario, Canada

Or use this handy order coupon.

Koolatron Industries Limited Dept. 1162

56 Harvester Avenue, Batavia, New York 14020
Canada: 230 Bayview Drive, Barrie, Ontario L4N 4Y8

Send me with full refund privileges:

____Koolatron P10 at $129.00 ($139.00 in Canada)

____Koolatron P34 at $169.00 ($179.00 in Canada)

____Koolatron P34A at $189.00 ($199.00 in Canada)

____Koolatron 110V adaptor at $29.95 ($34.95 in Canada)

Please add $8.00 for handling and delivery per unit.
No charge for shipping adaptor if ordered with unit.
Add $3.00 for shipping adaptor only.
(N.Y., Ont. and Quebec residents add sales tax.)

I understand that I may return any item undamaged within 21 days and receive a full refund if I am not satisfied.

☐ I enclose my check or money order for

$ _____ or please charge it to my
☐ Visa ☐ Mastercharge ☐ American Express

Account Number _____

Expiry Date _____

Signature _____
(necessary to send merchandise)

NAME _____

ADDRESS _____

CITY _____ STATE _____

ZIP CODE _____ PHONE _____

DCL1

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Edison introduces the reachable band saw.

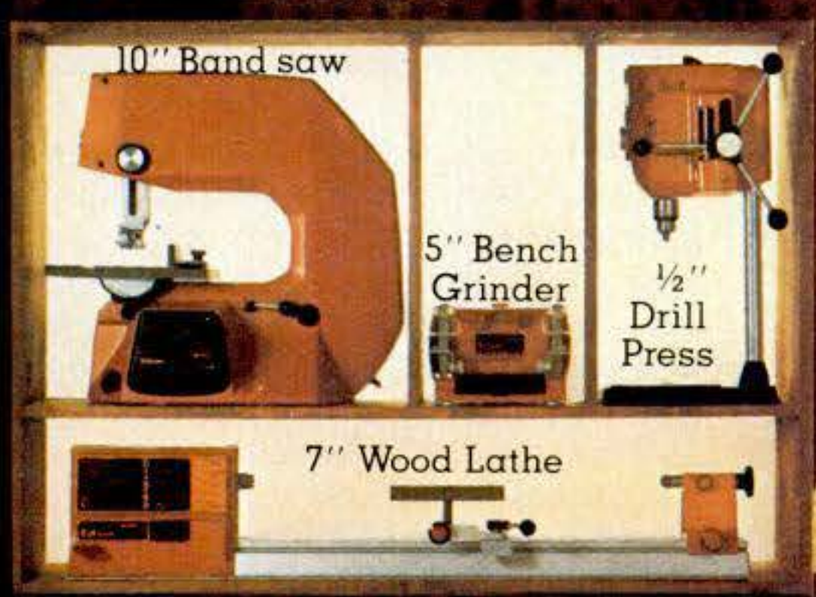
A fully functional 10" band saw for less than $150.

It fits right on your workbench, lifts out of the carton ready to work, and its ½ hp variable speed motor gives you the capacity and precision of stationary band saws that can take up twice as much room and a lot more money.

It cuts everything a good band saw should. Wood, plastics, ceramics and non-ferrous metals.

It's the new reachable band saw from Edison. Reach for it wherever you buy tools.

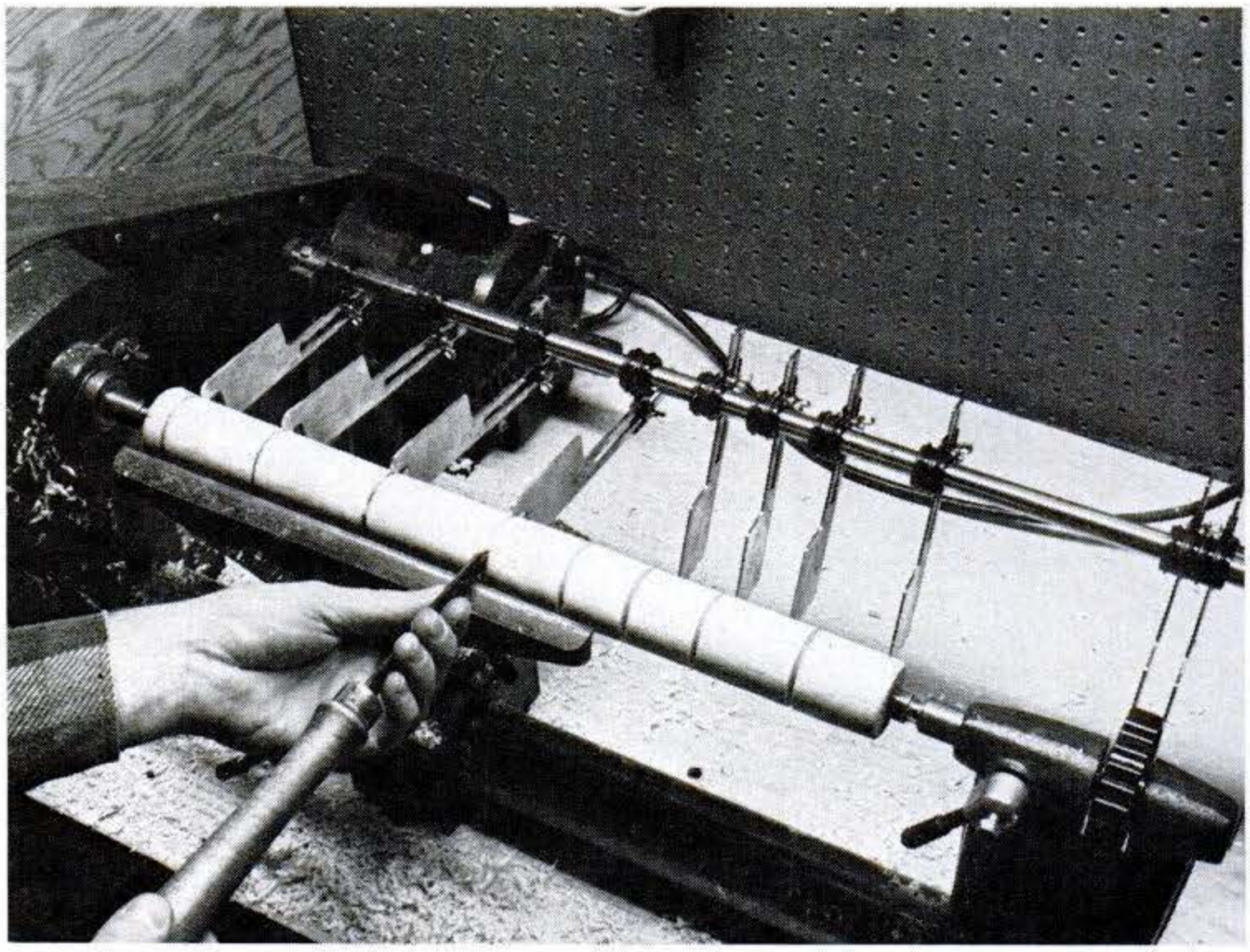
And reach a new level of craftsmanship.



McGRAW-EDISON

From the reachable workshop. **Edison** Bench Tools

Sizing gauge speeds lathe layout



The basic technique for turning identical spindles is to lay out a series of sizing cuts that represent the various diameters along the length of the turning. These create guide reference points as you do the rest of the work freehand. Ordinarily you make the sizing cuts with a parting tool and a caliper that has to be reset for each cut. But now there's a new tool that does away with the calipers, and speeds the tedious sizing operation so you can get on with the fun of freehand work.

It's a heavy steel tube from which hang 12 size indicators, enough for almost all work. Each is marked in diameters from zero to six inches (and in millimeters as well). To use this new gauge, rough turn the work to a cylinder. Then slide each indicator to the desired position along the bar, set it to the proper diameter, and rest it atop the work.

Now turn on your lathe, take your parting tool, and cut into the spindle opposite the first indicator. When you reach the preset diameter, the indicator will drop past the spindle and swing free. Move on to the next indicator and do the same. Continue until all sizing cuts are made. It's fast and foolproof.

Other advantages: The sizing gauge is made by Sears to fit the Craftsman 12-inch lathe, but I see no reason why it shouldn't work with most other lathes. It's easy to install and remove should it interfere with faceplate work. My only gripe is that the indicators rattle as they ride the work—a distracting noise. The diameter sizing gauge is Sears catalog number 9 HT 24909C, and it's priced at $32.99.—*A. J. Hand*

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Turbo Audi challenges Mercedes and BMW

ESTORIL, PORTUGAL

The something-for-nothing formula of turbocharging is catching on. In the Audi 5000S Turbo, the German firm's thrust into the top-luxury Mercedes/BMW class, it turns a sedate family notchback into a slingshot, upping power by 25 percent. I drove an automatic Turbo around a 120-mile test route near Lisbon, where it trickled along sweetly in town, but cast off its sheep's clothing on the open road.

I accelerated from zero to 60 mph in a mere 7.6 seconds, which is remarkable for a 134-cu.-in. engine in a 2770-lb. four-door. Boost comes on around 3000 rpm, but I could only feel its effect—there was nothing to hear.

In the U.S., top-end zip may not be required because of the 55-mph national speed limit, but the power reserve will give a wide safety margin for passing. Expect slightly less acceleration, though, since American cars will have reduced boost pressures to prevent detonation. In the European model I tested, the engine delivered 170 hp, with 195 ft.-lbs. of torque (a 43 percent increase). A five-speed is standard in Europe, but only the automatic will be imported.

Included in the package are heavy-duty suspension, larger light-alloy wheels with low-profile tires, and four-wheel disc brakes—all of which gives a smooth, taut ride. There's wall-to-wall carpet extending up the doors to fabric inserts in the roof, which hushes noise effectively. Windows have bronze-tinted glass, and there's lots of storage space. Standard equipment includes power windows and locks, a height-adjustable driver's seat, and an overhead digital clock.

Although I had no chance to check the automatic's fuel consumption,

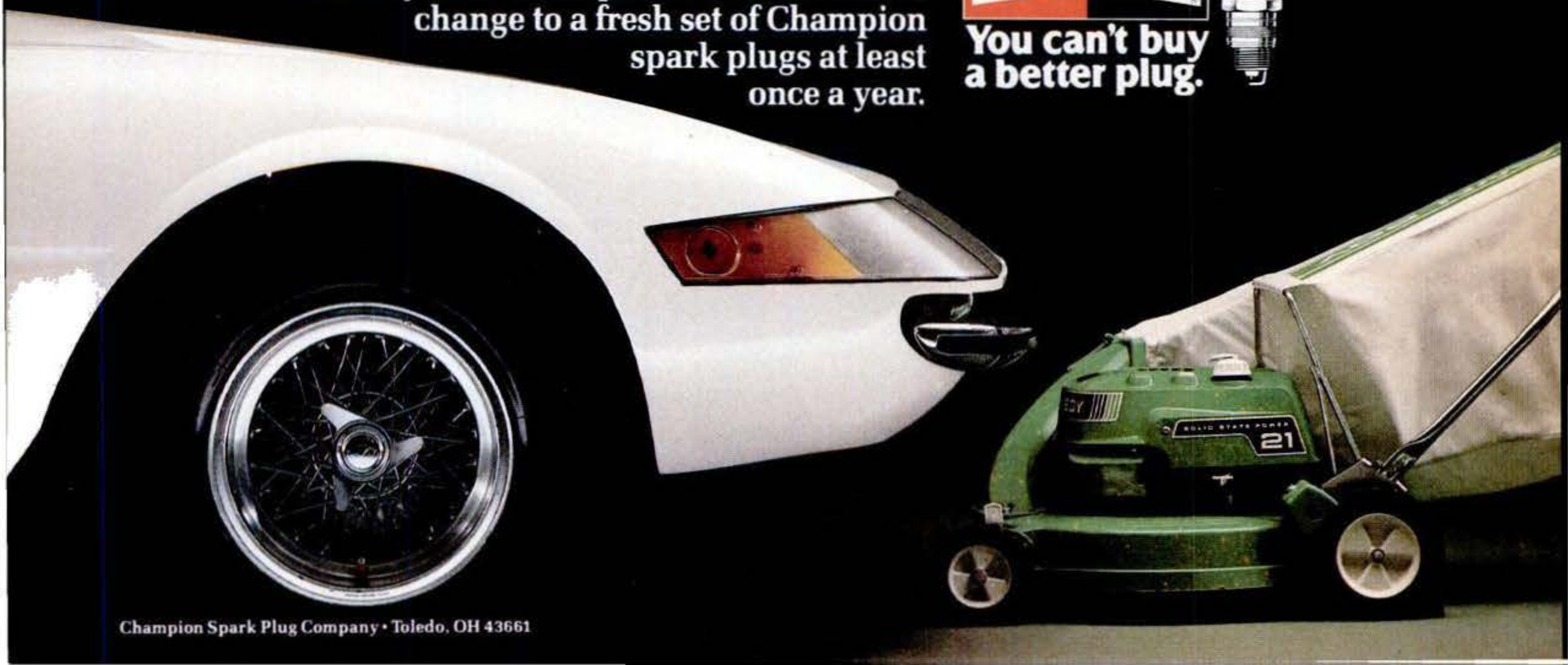
Audi gives it as 30.1 mpg at a constant 55 mph, and 18.9 on the European urban-highway cycle—not bad for a high-performance runabout. At around $17,000, Audi's new flagship should give its German rivals a real run for the market.—*David Scott*

Champion keeps Ferraris and Lawnboys clipping along.

Virtually every gasoline-powered car, implement, truck, airplane, you-name-it clips along smartly with Champion. For surer starts, change to a fresh set of Champion spark plugs at least once a year.

CHAMPION

You can't buy a better plug.



Champion Spark Plug Company • Toledo, OH 43661

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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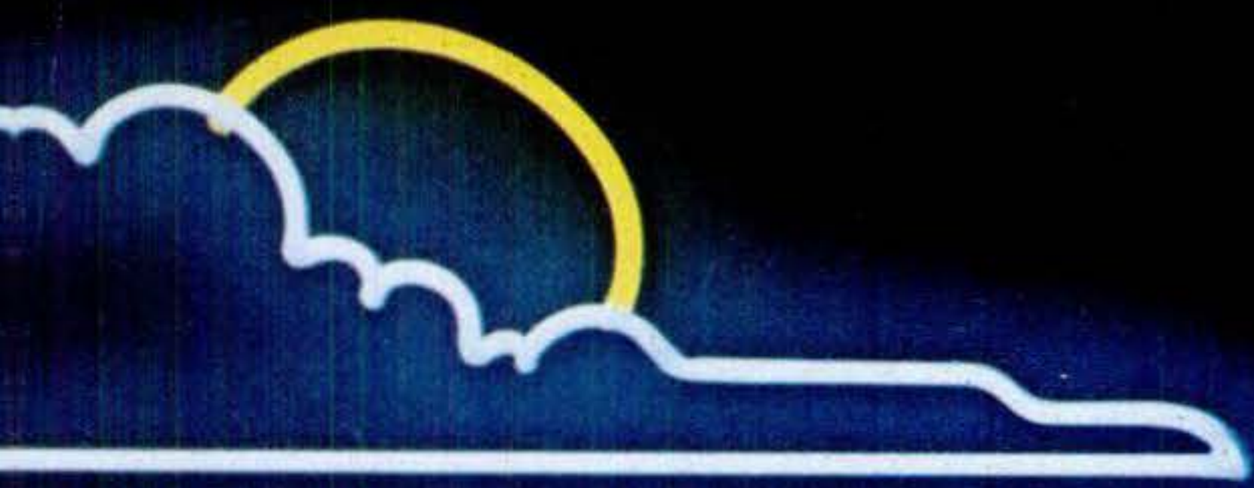

Lively Light Menthol Lights

Crisp refreshing taste in a low tar.

LIGHTS: 11 mg. "tar", 0.8 mg. nicotine, LIGHT 100's: 11 mg. "tar", 0.9 mg. nicotine, av. per cigarette, FTC Report DEC. '79.

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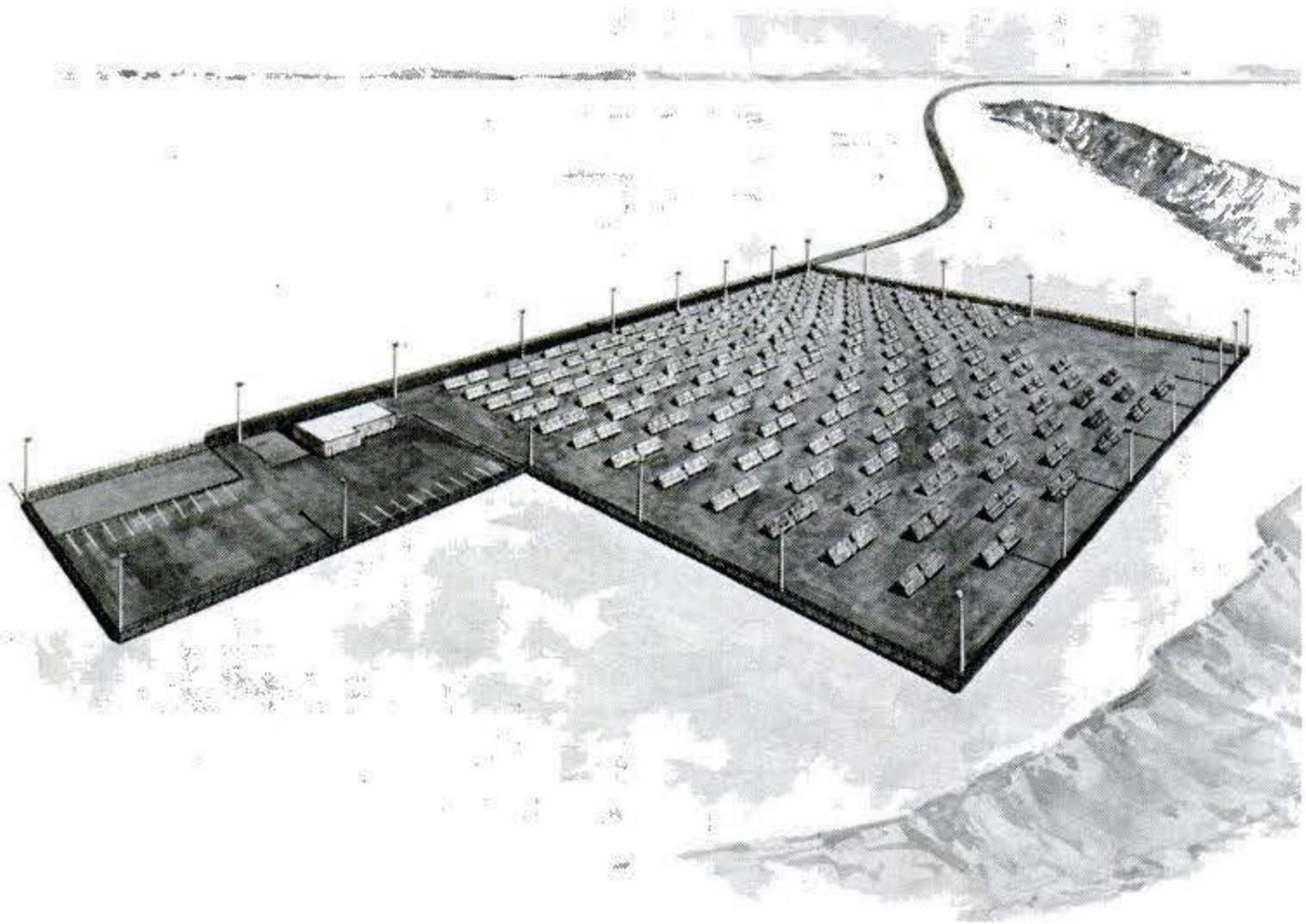
SCIENCE NEWSFRONT

By ARTHUR FISHER



Largest photovoltaic plant

Where would you guess the world's largest solar photovoltaic power plant is about to be built? The American Southwest? Some underdeveloped equatorial country pinched by rising petroleum costs? Nope. The answer is Saudi Arabia, which sits on the world's richest oil fields but, like its neighbor Kuwait [PS, May], wants to diversify its energy sources and free more oil for export.

The plant will be a joint venture of the United States and Saudi Arabia, under the auspices of a Joint Commission on Economic Cooperation, and is part of a five-year, $100 million effort on behalf of both countries—with benefits for each—to develop solar-energy technology. As seen in the artist's concept above, the photovoltaic array will sit on a hill between two villages located about 30 miles from the capital city of Riyadh, and furnish their combined populations of about 350 people with a peak output of 350 kilowatts DC power. Martin-Marietta company will design, build, and operate the system, which is to be completed by July 1981, under a $16.4 million contract with DOE's Solar Energy Research Institute.

Charcoal cloth

The oddly garbed gentleman above is wearing a face mask that incorporates a swatch of the black fabric he is admiring. Called charcoal cloth, the new fabric has unusually high powers of adsorption. It can not only block odors but protect

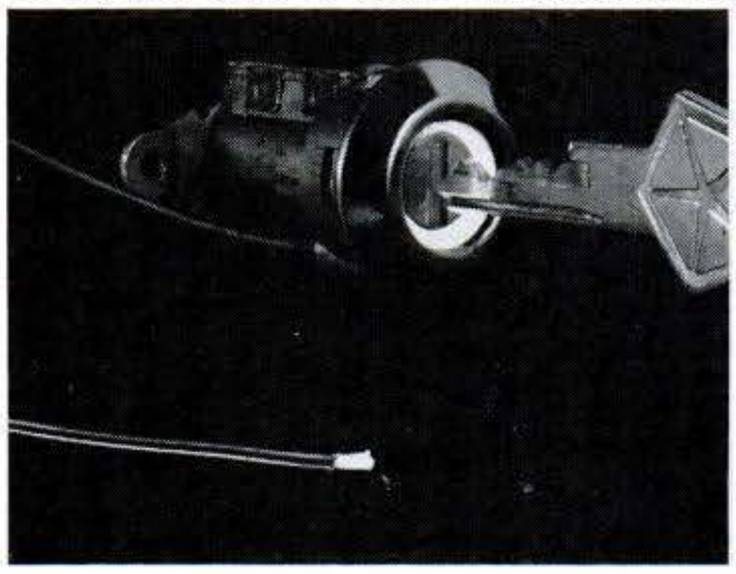
against toxic gases, purify water, filter engine intakes, and so on. Manufactured in England, the rayon cloth is pretreated so that it turns into activated charcoal with a very high internal surface area, with an adsorption capability up to 20 times greater than nut-shell charcoal. Britain's Chemical Defence Establishment developed the process.

A gem of a book

One of the most memorable dinners I ever attended was remarkable not so much for the food or the testimonials but because it was held in the Smithsonian Institution's Hall of Gems. The diners were surrounded by a coruscating collection of some of the world's most breathtaking baubles (and also by several armed guards . . . just in case). Now the Smithsonian Institution Press has brought all its glitter and color back to me, in a slender volume called "The Gem Collection," by Paul E. Desautels ($12.50). It's packed with gem lore, mineralogy simply explained, and splendid color photos of many of the outstanding items in the collection, including the Hope diamond and the huge Logan sapphire. Makes a handsome gift for almost anyone.

End fumbling with fiber

Some 1980 Chrysler Corp. cars are coming equipped with a new weapon in the titanic struggle to end fumbling with door locks and keys at night—an illuminated

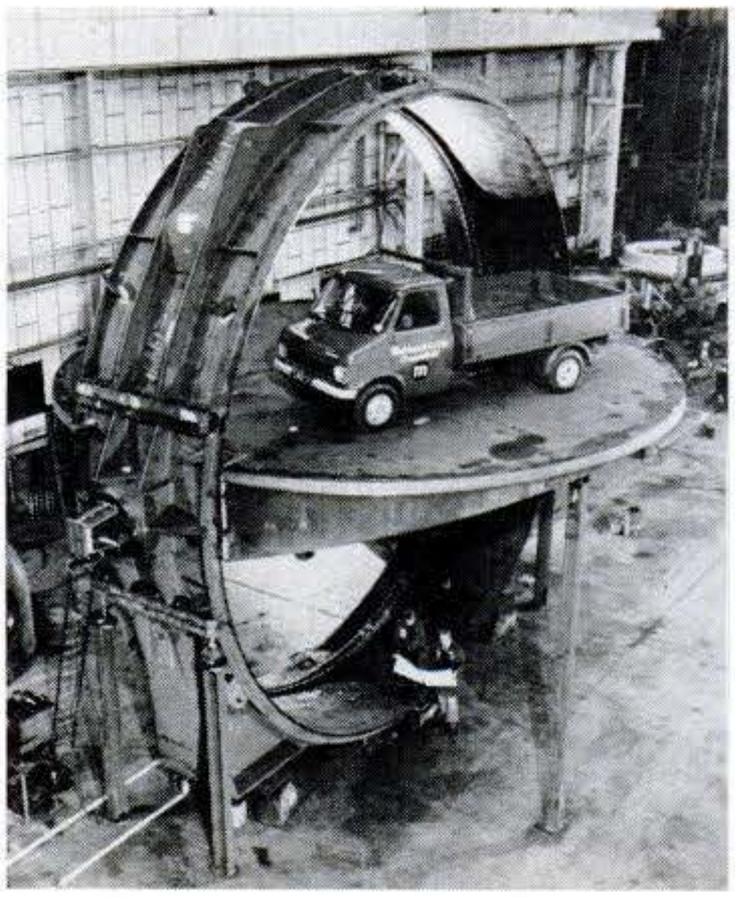


keyhole that relies on fiber optics. When you lift and then release either front-door handle, you automatically switch on a low-wattage light bulb in the door panel whose light is led through a foot-long light guide made of 48 strands of Du Pont's 10-mil Crofon optical fibers. The light reaches a plastic halo lens with the result you see in the photo. A section of the light guide appears at the bottom of the picture for size comparison.

Giant butterfly valve

This monster, reportedly the largest example of a butterfly valve in the world, is shown supporting a truck to give some idea of scale (or for some other, nefarious purpose as yet unexplained). It weighs 170 tons, is 32 feet across, and is destined for a new aircraft-engine test facility at Arnold Engineering Development Center in Tennessee, where it will be used as part of a half-mile-long building that will accommodate the largest engines now contemplated. The valve, which opens or closes off air flow with its movable disc, was designed by Boving and Co. and manufactured by Markham and Co., both of England.

Continued



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NOW FOR $75. THE WATCH THAT REPLACES EVERYTHING.

Introducing Casio's newest, the C-80 Calculator Chronograph. A watch that figures to replace a lot of other watches. And calculators. And stopwatches.

In fact, it even replaces the age-old myth that a timepiece loaded with talent has to be expensive.

The Casio C-80 is priced at only $75.

A calculator made for real fingers.

Here's the first calculator chronograph that can be operated easily with your fingertips. No need to use a stylus or pen; the keys are far enough apart that even the broadest fingers can work them.

Now you can add, subtract, multiply, divide—perform chain calculations up to six places, plus decimal. Numbers appear in crisp liquid crystal digits. There's even an indicator that tells you exactly which function is being performed.

Stopwatch, 2 time zones—and more.

The push of a button turns your calculator into a fiercely talented stopwatch. You get $1/100$ of a second accuracy, lap times, and up to 59.59 minutes of track-style timekeeping. Timing automatically starts over after the hour.

You also get two time zones; the second zone can be set for 12 or 24-hour time (especially useful for frequent travelers). Hours, minutes and seconds are displayed with reliable ±15 second-a-month quartz precision. AM/PM indicator is always visible.

Press another button, day of the week and date appear. And another for built-in night light.

Feather-light, yet rugged.

The 1 oz. case and band are constructed of high impact black plastic. And so lightweight and comfortable, you may not realize that on your wrist you're wearing—among other things—a clever calculator.

Other companies have tried introducing similar watches, only using bulky stainless steel. These steel versions sacrifice the comfort, lightness, and handsome appearance provided by the latest advanced plastics.

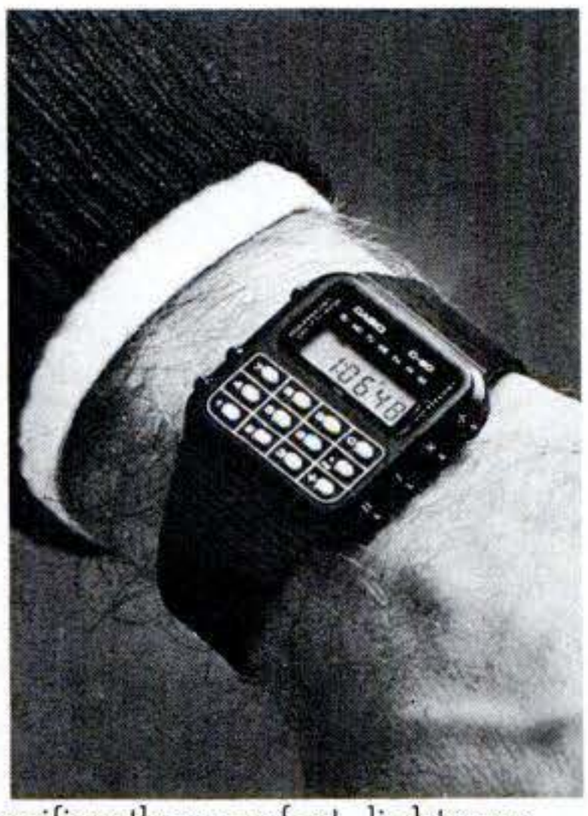
What's more, this Casio chronograph is built incredibly rugged to provide years of reliable service. There are no mechanical parts to wear out or break. A tough mineral glass crystal prevents scratching. And the tightly fitted case and crystal provide water resistance for everyday use.

Normal Time Display; hrs./mins./secs. AM/PM, day and 2 time zones.

Stopwatch Display; 1/100 sec. timing. Auto start-over at 1 hr. Lap times.

Calculator Display; add, subtract, multiply, divide—to 6 places with decimal.

Calendar Display; day/date. Auto end of month adjustment.



Reserve yours now.

You might wonder why you haven't seen this superb chronograph in the stores. The fact is, it isn't going to be in any stores—not for a while.

However, beginning late March 1980, The Sharper Image will be the first people anywhere to take delivery on these exciting Casios. And you can reserve yours now. But please order immediately to be assured of earliest delivery. As quantity is limited, orders will be handled on a first come, first served basis.

And as always, The Sharper Image guarantees your satisfaction. If not delighted with your new Casio, simply return it within two weeks for a full and courteous refund. One-year manufacturer's warranty and 15-month (normal use) battery included.

ORDER NOW TOLL-FREE

Please order product #134. Credit card holders may use our toll-free number below. Or send check for $75 plus $2.50 delivery. Add $4.50 sales tax in California.

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Ford.
The best gas mileage of any wagons built in America.

But that's what you'd expect from the Wagonmaster.

On January 5, 1929, Ford's first Woody rolled off the production line and onto the American Road. In that year Ford began a journey fifty years long, building more station wagons than anyone else, earning the right to be called Wagonmaster.

Today the Wagonmaster is also the Mileagemaster. 1980 Ford wagons have the highest mileage ratings of any wagons built in America. From roomy full-size LTD Wagons to versatile mid-size Fairmonts to value-packed Pintos, Ford wagons are built to stretch your gas dollar.

And Ford wagons are the most popular of all. Since 1949, Ford has sold a million more wagons than anyone else.*

When it comes to wagons, Ford's better ideas just keep getting better.

And that's what it takes to be the Wagonmaster.

BEST MILEAGE OF ANY WAGONS BUILT IN AMERICA.

WAGONS	EPA EST. MPG	EPA EST. HWY.	EST. RANGE	EST. HWY. RANGE
LTD (8-cyl.)	17	24	340	480
FAIRMONT (6-cyl.)	21	30	294	420
PINTO (4-cyl.)	23	38	322	532

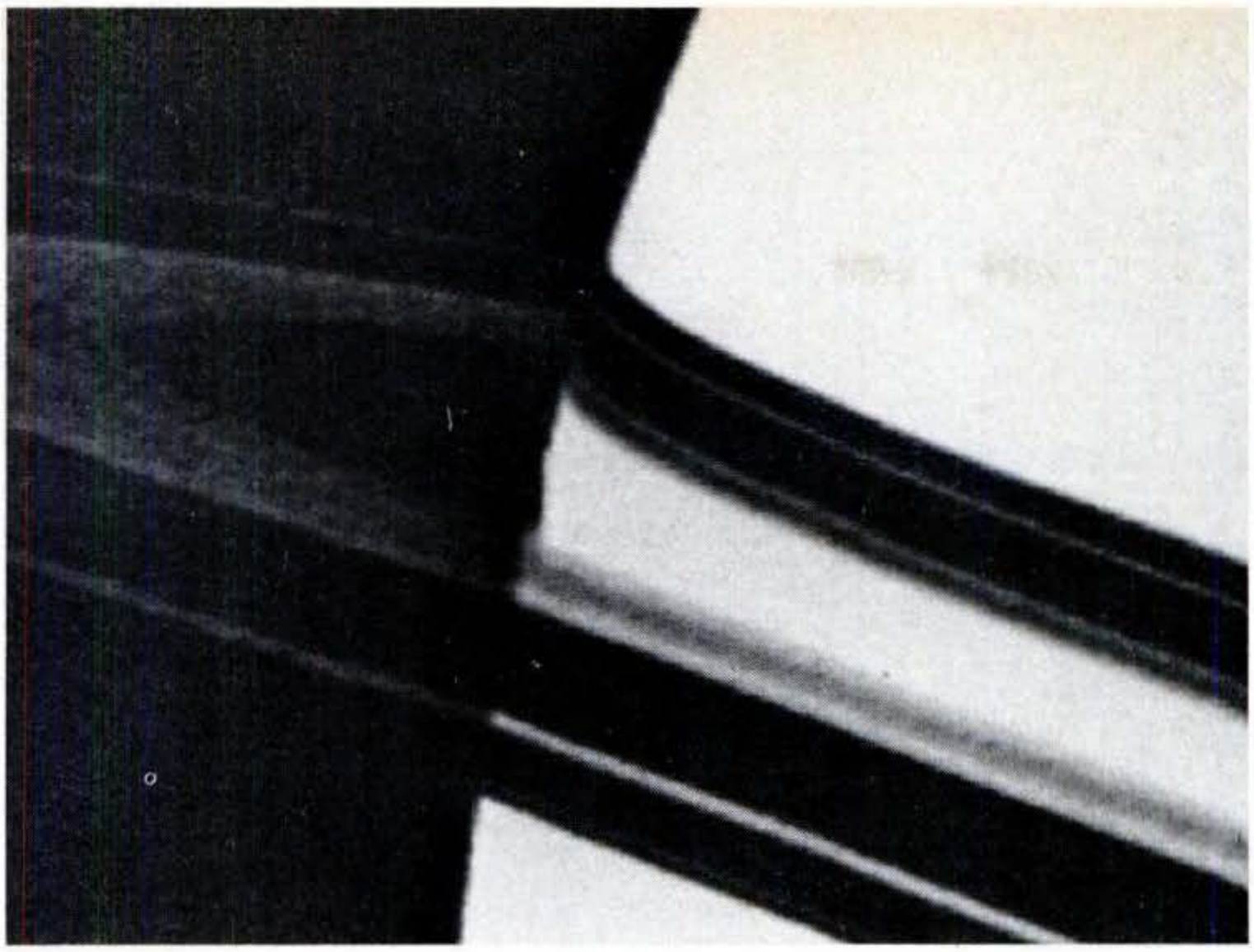
Use these estimates for comparison. Your mileage may differ depending on speed, distance and weather. Actual highway mileage and range will probably be less than estimates. Calif. estimates lower. Comparison excludes diesels and other Ford Motor Co. wagons. Ranges are based on EPA mileage estimates and LTD's 20-gallon gas tank, Fairmont's and Pinto's 14-gallon gas tanks.

*Based on R. L. Polk & Co. registrations.

FORD WAGONS

FORD DIVISION Ford

Wagonmaster-Mileagemaster. 1980 Ford.



Saturn's rings clarified

The Pioneer spacecraft flyby of Saturn gave us our best look at the rings that have entranced skywatchers for centuries, and the first look from their unlit side [PS, Jan.]. Now, further enhancement by NASA's photo wizards of this close-up view, received from Pioneer on September 1, 1979, when the craft was 395,000 km (244,900 mi.) from Saturn, provides a clearer idea of the rings and divisions.

Because the photo was taken from the unilluminated side of the rings, they appear visible only by sunlight glancing off particles of matter in the rings and through them. Because the B ring contains the most matter, it blocks out all light and appears jet black. The rings seen here, from the inside out, are the inner C ring; the middle, black B ring; the bright stripe of Cassini's Division—a major gap; and the outer dark A ring. You may be able to make out the Encke Division, which splits the A ring.

The upper broad black strip on Saturn's surface is the shadow of the rings. The lower pin stripe in the shadow is the Cassini Division; the upper pin stripe is the newly discovered "French Division," a wide gap between the B and C rings that had earlier been proposed by some French astronomers.

By the light of the moon

In the lexicon of folklore, moon doesn't rhyme just with tune and croon, but with babies. One of the hoariest of such beliefs is that more babies are born when the moon is full than at any other time of the month. Not so, according to two California scientists, George O. Abell and Bennett Greenspan, who analyzed almost 12,000 births recorded at the UCLA Hospital for four years. "My interest in the full-moon/high-birthrate claims was partially triggered because the belief is shared by many nurses in maternity wards, and even some gynecologists," says Abell, "whereas astrologers cite it as evidence that celestial bodies influence human affairs." But, Abell and Greenspan report, their analysis shows no correlation between the number of births and the full moon. Indeed, there were no surprising peaks or dips at any point in the lunar cycle.

Pocket logic tester

"What used to fill up the wall of a large room and weigh anywhere from 100 to 2000 pounds, we have been able to put in the palm of the hand, and I'd say that was a major technological breakthrough." So says Dr. William G. Steiner, an engineer at Lockheed-Georgia Company and the inventor of the new battery-powered digital logic tester you see in the photo below. Its built-in microcomputer can store more than 100 different procedures for testing integrated circuits, circuit boards, and modules. It has a four-character alphanumeric display and can be programmed with three push buttons. "Being able to count to three and feeling comfortable with four-letter words is all you need to operate it," says Steiner. Lockheed will apply it to building aircraft, but its greatest potential may be for trouble-shooting malfunctions away from the factory. PS

Ford wagons and the option that could pay for itself.

A better protection idea from the Wagonmaster.

Just ask your Ford Dealer.

When you order your new Ford wagon, be sure to consider the one option that could pay for itself. Ford Motor Company's Extended Service Plan. It's available to help protect you against rising service costs. And it's backed by Ford Motor Company and honored by participating Ford Dealers nationwide.
To learn more about what this plan covers and what it costs, see your Ford Dealer.

The option that could pay for itself.

Ford EXTENDED SERVICE PLAN

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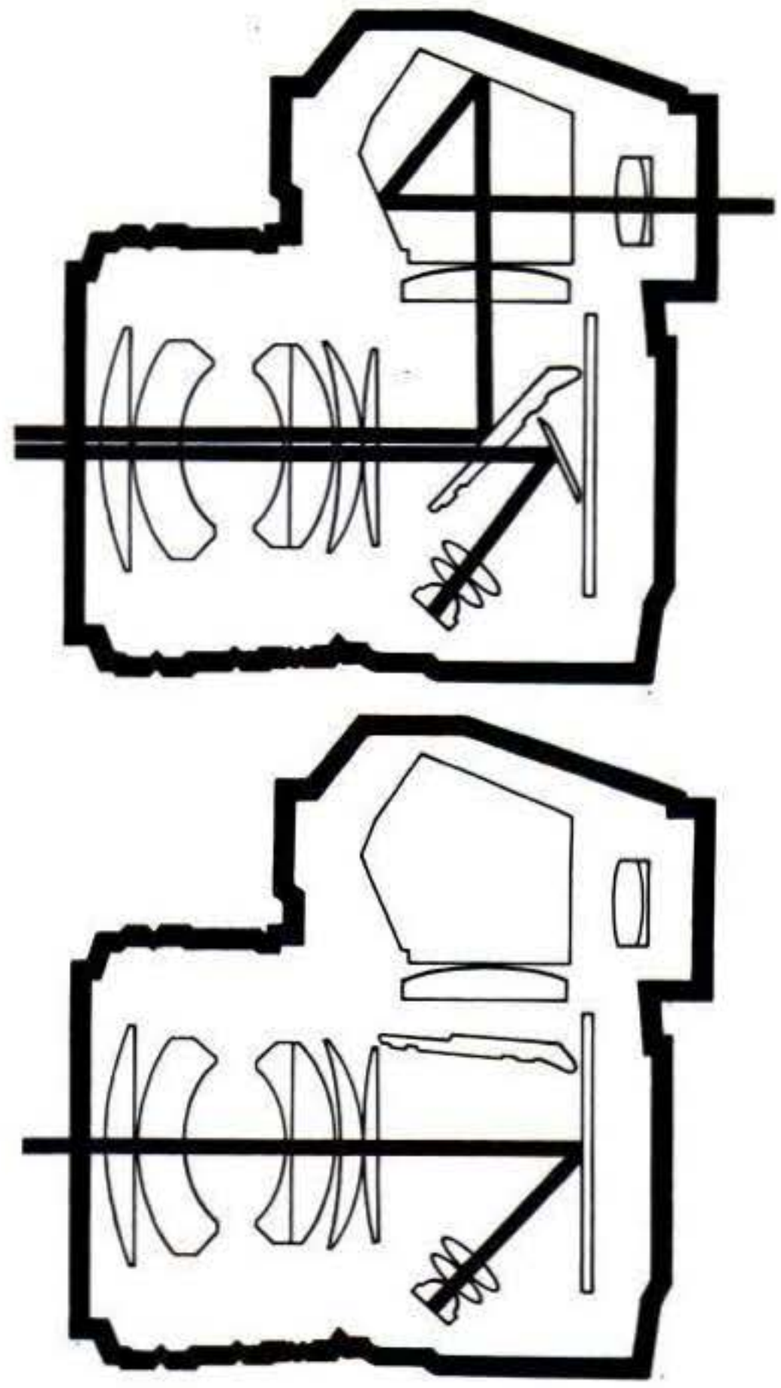
THROUGH THE VIEWFINDER

By EVERETT H. ORTNER



And now . . . Nikon's F3

For serious photographers, both professional and amateur, the introduction of no 35-mm SLR camera is met with the interest that a new F-series Nikon arouses. Since the first Nikon F appeared more than 20 years ago, Nikon SLR's have been the overwhelming choice of professional photographers. Now there is a new professional-caliber Nikon, the F3, succeeding the F2.

It illustrates an interesting trend: Where, once, professional features tended to appear later on amateur cameras, now features designed for amateur convenience show up later on cameras designed for the professional. Through-the-lens exposure metering was an early example. Automatic exposure, now built into the Nikon F3, is a current example. So is automatic flash. Even the most experienced photographers are learning to trust the judgments of microprocessors.

There is a major difference between the F3 and its predecessors in design philosophy: With the F3, more is built into the body and less into the finder than is the case with the F and F2 models. You could, for example, convert an F2 Nikon to an F2A by the simple substitution of an F2A Photomic finder for the F2 finder; the finder contained the metering system, and changing the finder changed the method of metering. The earlier F was modernized several times with new finders. With the F3, the finder is truly a finder: an optical device for viewing the focusing screen. The electronics and the shutter-speed dial are now built into the camera.

The F3 contains not so much novel features as tried-and-true ones. One major exception: a liquid-crystal display, in the viewfinder, of the shutter speed. Or to be more accurate, during automatic exposure the LCD shows the shutter speed closest to the operative shutter speed. The electronic metering system makes possible any fraction of speed between 1/2000 second and eight or more full seconds. The LCD uses less battery power than the common LED displays.

Now to some other facts and figures:

Dimensions. Although the F3 is only a smidgen smaller than the F2A, it is a full 4.6 oz. lighter: 24.7 oz. versus 29.3.

Metering. The F3 reads its exposure right off the film, a la the Olympus system and the Contax 139 Quartz ["Viewfinder," PS, Feb.]. A portion (eight percent) of the light enters the lens (top right), passes through some 50,000 microscopic holes in the mirror's silver, then strikes a secondary mirror that reflects it to a silicon photodiode (SPD) cell for the exposure reading. During the actual exposure, when the main mirror is in its raised position (lower drawing), the SPD cell takes its reading from light reflected directly off the film. The reading is weighted: 80 percent toward a 12-mm area in the center.

The shutter. The shutter curtains are made of quilted titanium for durability and low mass. Shutter timing, in the manual mode, is controlled by a quartz crystal for superaccuracy.

Flash. The F3 has its hot shoe over the film-rewind crank. Slip the SB-12 flash in place and it automatically links up with the camera's electronics, which sets the shutter speed and signals, via a ready light in the viewfinder, when the flash is ready. That SPD metering the exposure controls the flash, turning it off when exposure is right.

Motor drive. The MD-4 motor drive is the fastest standard drive on the market, Nikon claims—up to six frames per second. A nice touch: With the motor attached, the camera gets its power from the motor's batteries, saving its own.

For insurance, in case all batteries have failed, the F3 can be operated mechanically, at a speed of 1/60 second.

Prices? The F3 body is $947, the motor drive is $380, and the SB-12 flash, $138. Sorry you asked?

Creative filters

Filters aren't for everybody. Most photographers, even some of the most serious, rarely go beyond the two most common filters: skylight and polarizing. One reason, of course, is the nuisance of screwing and unscrewing them. *Continued*

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THIS AMAZING NEW BEERMAKING KIT LETS YOU MAKE HUNDREDS OF GALLONS OF SUPER DELICIOUS BEER . . . FOR JUST PENNIES A BOTTLE.

An amazing new breakthrough in home beer making has been developed in England. Now it's available here in America.

This easy-to-use kit allows you to make hundreds of gallons of beer for just pennies a bottle. What's more the beer tastes BETTER than most commercial beers. And you can brew this delicious beer in your own kitchen IN JUST 27 MINUTES. It's as easy as baking a pie or cake.

Let me repeat—by using our special imported hops, and our new 7 gallon anaerobic fermenter your homemade beer will actually taste BETTER THAN MOST COMMERCIAL BRANDS. WE GUARANTEE IT. Compare it to any of the famous imported beers costing $15.00 to $20.00 per case. You'll be amazed. The taste is superb . . . clear . . . full bodied . . . with a thick creamy head. So good you won't believe you made it yourself!

Following is an interview with Bud Weckesser, President of Bierhaus International.

QUESTION: *HOW CAN ANYONE MAKE BEER AT HOME AS GOOD AS COMMERCIAL BEER?*

ANSWER: That's like asking how Grandma could make cookies as good as the cellophane wrapped kind you buy in the supermarket. As you know, homemade products are usually BETTER than their commercial counterparts. Pie, spaghetti sauce, cake, fried chicken, . . . almost anything. The fact is, most Americans have never tasted really good beer. Ask any G.I. who was stationed in Germany. The Germans brew a "homemade style" beer in local breweries. It has more body, flavor and head than almost any American brand. Yet it's light without being watery.

QUESTION: *YES, BUT MANY OF US HAVE TASTED OLD FASHIONED "HOME BREW" AND IT WAS OFTEN-YEASTY AND FLAT.*

ANSWER: The beer I'm speaking of is as different from "home brew" as ducks are from bananas. Old fashioned "home brew" was made from granulated sugar plus grocery store yeast. And it was usually made in a crock or metal pot. This produced a sour bacteria laden concoction that was barely drinkable.

The new Bierhaus products are entirely different. For example, we offer Hallertauer hops—the same kind used in making the finest German, Dutch and Danish beers. One of our yeast cultures is the same one used in many premium beers of the U.S. and Denmark. We also include pure dextrose—not granulated sugar. But most importantly every kit includes a self-sealing anaerobic fermenter made of F.D.A. food grade polyethylene. The beer ferments in a totally bacteria free environment—just like they use in many commercial breweries. The CO_2 generated during fermentation bubbles out through a small water filled air lock to produce the clearest light or amber lager you can find anywhere.

An unretouched photo of our Bierhaus Light Lager after only two weeks aging . . .

QUESTION: *BUT ISN'T MAKING BEER AT HOME A COMPLICATED PROCEDURE?*

ANSWER: Not at all. Here's all you do—

ONE: Boil a 2½ quarts of water. Add the ingredients and pour the mix into the fermentation tank. Add 2 gallons of cold water, snap on the lid and let stand at normal room temperature for 7 days (65°-80°F.).

TWO: At the end of seven days, siphon the beer into another vessel and then into prerinsed empty beer bottles. The E-Z siphon hose, the fermentation tank, the caps and all of the ingredients are included in the kit. We can supply an inexpensive capper or you may obtain one from any hardware store.

THREE: Let the beer age 2-3 weeks. Chill the bottles, then drink it. For extra delicious flavor, allow the beer to age 5-6 weeks.

QUESTION: *CAN I MAKE DIFFERENT KINDS OF BEER?*

ANSWER: Certainly. Just vary the ingredients and recipes according to the instructions supplied with each kit. You can make—

- Light Lager—comparble to most American premium beers and some light European lagers.
- Continental Amber Lager—more body with a slightly "hoppier" flavor. Comparable to the original German and Dutch lagers served throughout Europe.
- Bavarian Dark Lager—full bodied yet not bitter. The head is incomparable—thick and creamy often rising an inch over the top of the glass.
- You can also make delicious Ale and Stout.

QUESTION: *BUT HOW CAN IT BE MADE SO INEXPENSIVELY?*

ANSWER: The kit can be used over and over again for years. It's truly a life time investment. All you have to do is re-purchase as many ingredients packs as you wish. The one-time cost you pay is easily made up by what you save on your first several brewings. After that you're paying only a few cents a bottle for one of the finest beers in the world—brewed by you. You can ACTUALLY SAVE HUNDREDS OF DOLLARS EACH YEAR.

QUESTION: *WHAT'S THE ALCOHOLIC CONTENT OF THE BEER?*

ANSWER: You can vary the alcoholic content of this beer to your own taste. You can make it as light or as strong as you wish simply by varying the recipe. Tests conducted by a testing laboratory indicate that our beer contains significantly FEWER CALORIES and FEWER CARBOHYDRATES THAN COMPARABLE COMMERCIALLY MADE BEER—a real bonus for those who are weight conscious.

QUESTION: *IS IT LEGAL TO MAKE THIS BEER AT HOME?*

ANSWER: By Act of Congress (H.R. 1337) effective February of 1979, any single person 18 years of age or older may produce 100 gallons per year tax free. In a household of two or more persons over 18, the limit goes to 200 gallons per year tax free. NO FEDERAL LICENSE IS REQUIRED—local laws may vary.

CUSTOMER COMMENTS

"I was a Pabst drinker till I switched to your beer. I'm a permanent convert. Your beer is excellent."
Donald McDuffee—Michigan

"Better tasting than (commercial) Premium beer—at half the cost. Enclosed is my re-order for more . . ."
Don Smeltzer—Michigan

"Our first batch was excellent after only 15 days aging . . . it just keeps getting better."
Jack Dennis—Ohio

"I've just bottled my 16th case of your beer. My friends and I all agree your beer is better than commercial beer. It's the only beer I serve at my home bar."
Frank Schmitt—Pennsylvania

"The best tasting beer we've ever had. I can't drink any kind of domestic beer because I'm allergic to the chemicals in it. But this beer (without any additives) doesn't bother me in the slightest."
Marie Killinger—Arizona

TRY OUR BLINDFOLD TASTE TEST . . .

We'll send you $5.00 FREE if you don't agree our beer is better than your present brand.

We'd like you to actually SAMPLE this beer. But most of you aren't going to drive to Erie, Pennsylvania, for a taste.

So we're offering you **$5.00—FREE—if you don't agree our beer is BETTER than the brand you're now drinking.**

TEST RULES

1. Request the kit. If you're concerned about sending a check, just charge it to your Master Charge or VISA.
2. We'll ship your kit immediately by U.P.S. You pay shipping charges on arrival. For EXTRA FAST SERVICE, call us at 814-459-3040 between 8:30-5:00 on weekdays.
3. Make one batch of beer—it brews in a large kitchen pot or pan in just 27 minutes. Bottle it in regular commercial beer bottles with caps and hand capper, also available from us.
4. Let it age FOUR weeks at a temperature between 65-80 degrees F.
5. Chill a bottle. **Taste test it against your favorite American beer.**
6. If you don't agree that our beer is better than the beer you're now drinking, just put everything back in the carton and return it to us within 45 days of purchase date. We NOT ONLY REFUND YOUR MONEY—WE PAY THE RETURN POSTAGE . . . AND SEND YOU AN EXTRA FIVE DOLLARS FOR YOUR TIME AND TROUBLE. THIS IS OUR UNCONDITIONAL GUARANTEE.

Bierhaus International
2041 West 12th Street Dept. 52
Erie, Pennsylvania 16505

Okay, folks—this beer better be good. Send me your basic kit for $29.95 plus postage. I'll compare it to my present brand. And if I don't think it's better than my brand, I'll send it back and you'll return my $29.95 AND SEND ME AN EXTRA $5.00. On that basis here's my $29.95.

FOR EXTRA FAST SERVICE
call 814-459-3040
and order your kit
using your VISA or MasterCharge.

NAME _____

ADDRESS _____

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☐ Check Enclosed ☐ VISA ☐ MasterCharge

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Find out all about them in our free pocket knife booklet. Send 25¢ for postage and handling to W. R. Case & Sons Cutlery, Dept. Q, Bradford, PA 16701.

CASE

The world's finest cutlery

Case — the officially licensed knife for the 1980 Winter Olympics.

Through the viewfinder

[*Continued*]

Now much of the nuisance can be eliminated. A new system, designed by a French photographer named Jean Coquin, has been introduced by the Minolta Corp. into the United States. Heart of the Cokin system (its Americanized name) is a cleverly designed holder that screws onto most standard lenses (49, 52, 55, or 58 mm) by means of an adapter. With the holder in place, filters can be easily slipped in and out. Double grooves in the holder enable you to use two filters at once for elegant and unusual results.

Almost the best part of the Cokin system is the 40-page booklet that tells you how to use and combine the filters. It's the best I've seen on the subject. Filter holder, lens cap, and booklet are $2.99. The lens adapter is $3.50. Filters cost from $7.50 up. And the system includes close-up lenses ($8.50), split-field lenses that put both background and foreground in focus, and a host of special-purpose filters and masks. The system is now appearing in camera stores.

Ambico, Inc. (101 Horton Ave., Lynbrook, N.Y. 11563) has a system that in many ways resembles the Cokin system. It is centered around a standard adapter ring for seven different lens sizes, and a filter holder that accepts two filters or masks, or a lens cap. Ambico's catalog/booklet showing the effects of different filters is excellent. Prices: filter holder, lens cap, and booklet are $2.95. Adapter rings are $2.95. Filters are $6.95 to $11.95, except for polarizers, which are $14.95.

All-around bag

Its makers bill it as the "shockproof camera bag." It's padded all around: top, bottom, and sides. But what most impresses

me is the Concept bag's thoughtful design: zippered end pockets that can hold 20 boxed rolls of 35-mm film or accessories and a center equipment-organizer insert that can hold two 35-mm camera bodies and up to six lenses, plus odds and ends of gear. Within the insert, four hinged "doors" swing open to enlarge the compartments or close against Velcro locks to divide the space into more and smaller compartments. You can also remove the insert entirely, if you wish. The Concept bag is made of tough nylon, weighs about 2¾ lbs., measures 19 by nine by eight inches. Kangaroo, 455 E. 10th Ct., Hialeah, Fla. 33010. $69.95. PS

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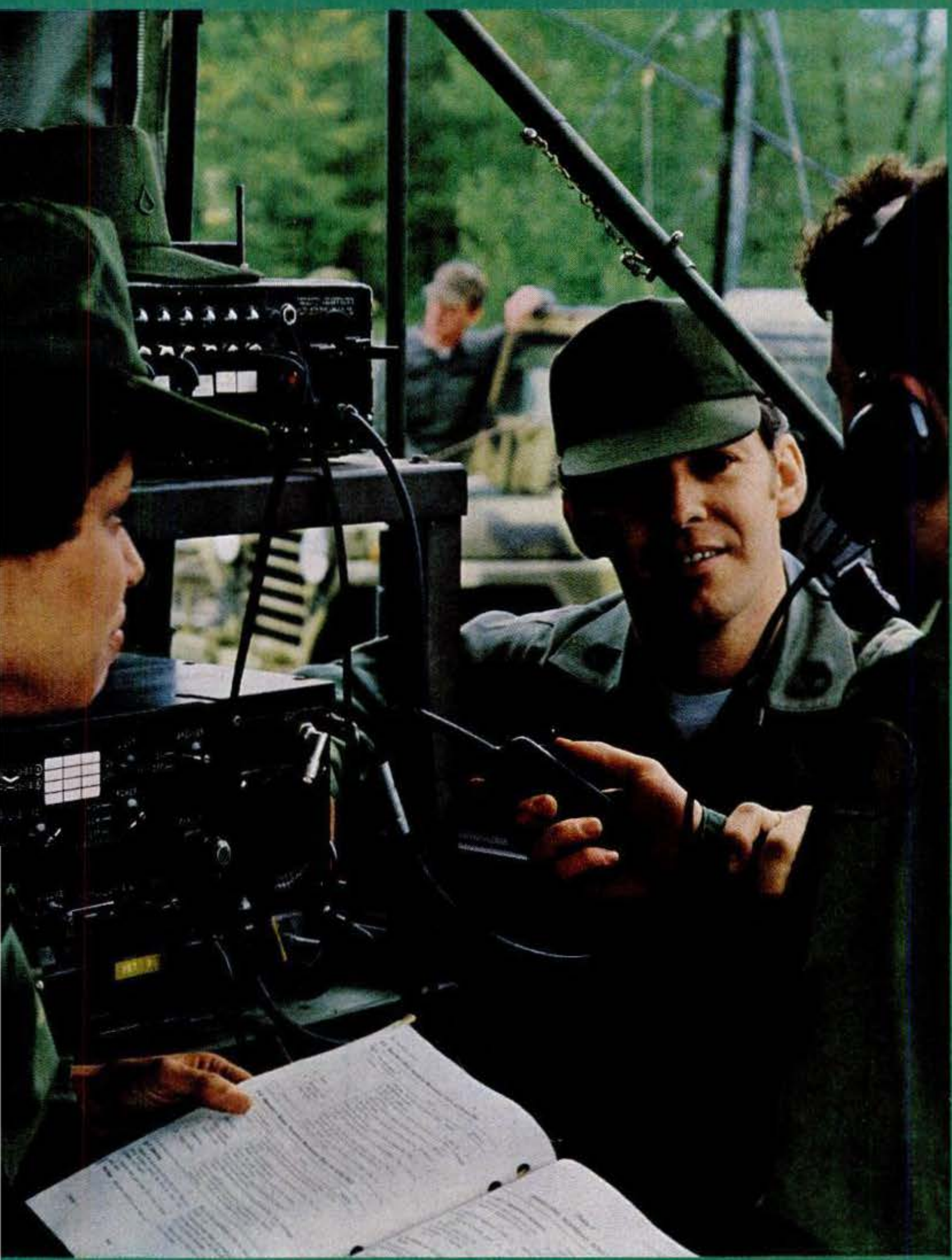
Somebody needs what you've already got. Pass it on.



You came out of the service with a lot going for you. Skill. Knowledge. And experience. And much of it didn't come out of a book or a tech manual. It came from somebody else. Somebody who took the time to pass along what he knew.

Well, what about you? You've got a lot to give, too. And you can do it. Part-time. In the Army National Guard.

In the Army Guard, you can make a difference. By working with people who

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ARMY NATIONAL GUARD

The Guard belongs.

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Luxury cars

The U.S. challenges Europe

By JIM DUNNE and ED JACOBS
PHOTOGRAPHS BY GREG SHARKO

It sounds like a contradiction, but even luxury cars are being affected by skyrocketing fuel costs. In fact, most recent "advances" in luxury-car design are aimed directly at mpg improvement.

With that in mind, we selected five highly visible examples of current luxury-car design: BMW 528i, Cadillac Seville Eleganté, Chrysler LeBaron Fifth Avenue, Lincoln-Continental Mark VI, and Mercedes-Benz 300SD. We chose this diverse cross section rather than a group of tightly bunched direct competitors to illus-

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements, and they reflect *only* our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	BMW 528i	Cadillac Seville	LeBaron Fifth Avenue	Continental Mark VI	Mercedes-Benz 300SD
Acceleration	5	0	5	5	5
Braking	2	3	2	1	3
Handling	4	1	4	2	4
Maneuverability	**	4	5	5	5
Quietness	5	3	3	2	2
Roominess	3	4	4	4	4
Visibility	5	2	4	3	3
Entry/exit ease	5	4	4	4	5
EPA economy	3	4	2	2	4
Ride comfort*	5	5	5	5	5

*authors' opinion
**damaged, could not complete tests

Luxury cars like the five seen here can be plush, practical, performance-oriented, or even economical (clockwise from foreground): Mercedes-Benz 300SD, Cadillac Seville Eleganté, Lincoln-Continental Mark VI, Chrysler LeBaron Fifth Avenue, and BMW 528i (inset photo).

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Attractive Air Alive unit measures only 4½" x 4" x 1¾" and cleans a 20' x 15' x 8' room in up to 15 minutes.

AIR ALIVE

Uses "Nature's Air Cleaners" to electronically destroy odor, smoke, dust, and pollen. Now research shows it may do more!

Little-understood particles, called negative ions, are said to be nature's best air cleaners. They attach themselves to dust, smoke, pollen or anything else floating in the air, and cause it to fall harmlessly to the ground. Now there is growing proof that negative ions may affect your moods, health and sense of well being.

THE ION CONTROVERSY

For the past 20 years, scientists and scholars-world wide have been studying the effects of electronically charged particles in the air called negative ions.

Russian scientists have recently proven that the presence of ions in the air is essential to animal life. Research conducted at the University of California has shown that plant growth is stunted when the ion content in the air is decreased.

Some researchers claim there's evidence that negative ions can relieve allergic ailments and headaches, help control virus, retard the growth of bacteria, increase mental alertness and energy, reduce pain, tension, fatigue and depression and produce sound sleep.

Interestingly, while the number of those who believe that negative ions do, in fact, produce these benefits, has grown, the number of doubters has decreased over the years.

THE ION IMBALANCE

The air is made up of molecules that contain either a majority of electrons, making them negative particles, or a majority of protons, making them positive particles.

Although nature produces a nearly equal number of positive and negative ions, there are a number of reasons why we are surrounded by an over abundance of protons: air pollution depletes the number of negative ions in the air, the static charge from synthetic fibers produces positive ions and natural earth radiation, that would normally produce negative ions, is retarded by concrete and asphalt covering the land.

In effect, we are breathing air that nature never intended us to breathe ... air that has been depleted of negative ions. What is needed is a way to correct this ion imbalance.

NATURE'S AIR CLEANERS

There is almost no disagreement among scientists that negative ions are unmatched in their ability to cleanse the air of impurities. This is how they do it: negative ions attach themselves to dust, smoke and pollen, neutralize them and cause them to fall harmlessly from the air.

Engineers and doctors have recently recognized this benefit and have begun to take advantage of it. Many now use commercial units that emit negative ions and effectively destroy odors and pollutants in the air.

It has only been during the last year that technology has developed an affordable consumer model. These units were first introduced in Europe where there is a high level of interest in the benefits of negative ions.

Now we are introducing one of the first consumer units to be sold in this country!

ONE OF THE FIRST UNITS UNDER $100

When we were offered the opportunity to introduce Air Alive to the American market, we jumped at the chance! Why? Because it's one of the first consumer models in this country to be sold for under $100. And because it's manufactured by Western Systems, Inc., a pioneer in the ion generation field.

MOST COMPACT UNIT ON THE MARKET TODAY

Air Alive measures only 4½" x 4" x 1¾" and puts out 3 trillion negative ions per second per cubic centimeter. That's as many or more than larger, more expensive units now on the market. It is so powerful that it cleans a 15' x 20' x 8' room in up to 15 minutes. Air Alive brings you more cleansing power in its compact size.

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Air Alive is an all solid state unit ... it has no moving parts. The unit is so trouble free that it is warranted by Western Systems, Inc. for two full years, in the unlikely event that anything should go wrong.

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Now Western Systems, Inc. brings something new to the American market that Europeans have used for years ... an optional auto adapter that allows you to use your Air Alive home model in your car, truck, van or RV. Hardware included for mounting under your dashboard and adapter plugs into your cigarette lighter.

30 DAY NO-RISK TRIAL

We believe Air Alive to be the most compact negative ion generator on the market today. It will destroy the dust, smoke, pollen and odors in the air in your home, office or car.

And we want you to decide for yourself whether or not you can benefit from the effects scientists are claiming that negative ions can have on your health and sense of well being.

We offer you a 30 day, no risk trial period on every Air Alive unit you order. If during that time you decide the Air Alive unit does not meet your expectations, for any reason, you can return it for a prompt refund of the purchase price.

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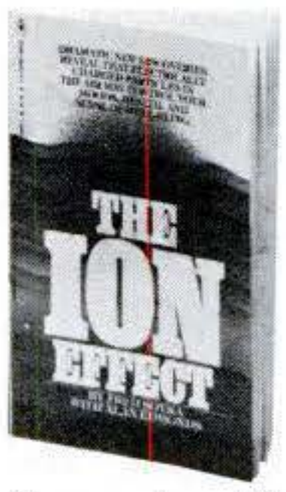
Simply fill out the coupon and send it, along with your check or money order, to the address below. For even faster service, call Toll Free: **1-800-527-7066.** In Texas call **(214) 349-3120.**



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Redesigned Mark VI was nearly five mph faster through low-speed maneuverability test than '79 model. It edged out Seville, but couldn't equal Mercedes or Chrysler.

trate the broad range of choices available today in the luxury class.

The three American cars are new this year and are flagships of their lines. The two German cars are outstanding examples from engineering-oriented firms. Each car, in its own way, offers outstanding ride comfort, posh interior appointments, and attractive styling. Further, two of them offer outstanding fuel economy, something not normally expected in luxury cars.

BMW 528i

BMW products tilt toward function and sportiness to an extent you don't find in competitive sedans. They are grand-touring cars first and foremost, and luxury cars second—not that luxury is overlooked. For example, while their seats are easily the most comfortable in the group, they aren't designed just for comfort. Their primary purpose is to securely locate you to feel the forces acting on the car, so that you can drive better and more safely.

For a luxury car, the 528i is no pussycat. It was the shortest, narrowest, lightest car in the group, and by far the quickest, despite having the smallest engine. The 170-cu.-in., overhead-cam, fuel-injection six pushes the spunky sedan to 60 mph a full second and a half faster than the 351-cu.-in. V8-powered Mark VI. Despite being shod with four snow tires, the BMW tied the Mercedes and Chrysler for top time in high-speed handling, and turned in the best hot-braking performance.

Inside, you'll find the driving position and all-around visibility to be excellent. The cockpit has been laid out as though by an aircraft designer, with highly readable gauges grouped neatly in front of the driver. Even though it's shortest, the BMW has the most front legroom. The big surprise, though, was that the car was markedly quieter than the others—quite startling in view of its high-performance character.

The BMW's EPA ratings are also good, equaling that of the Mercedes

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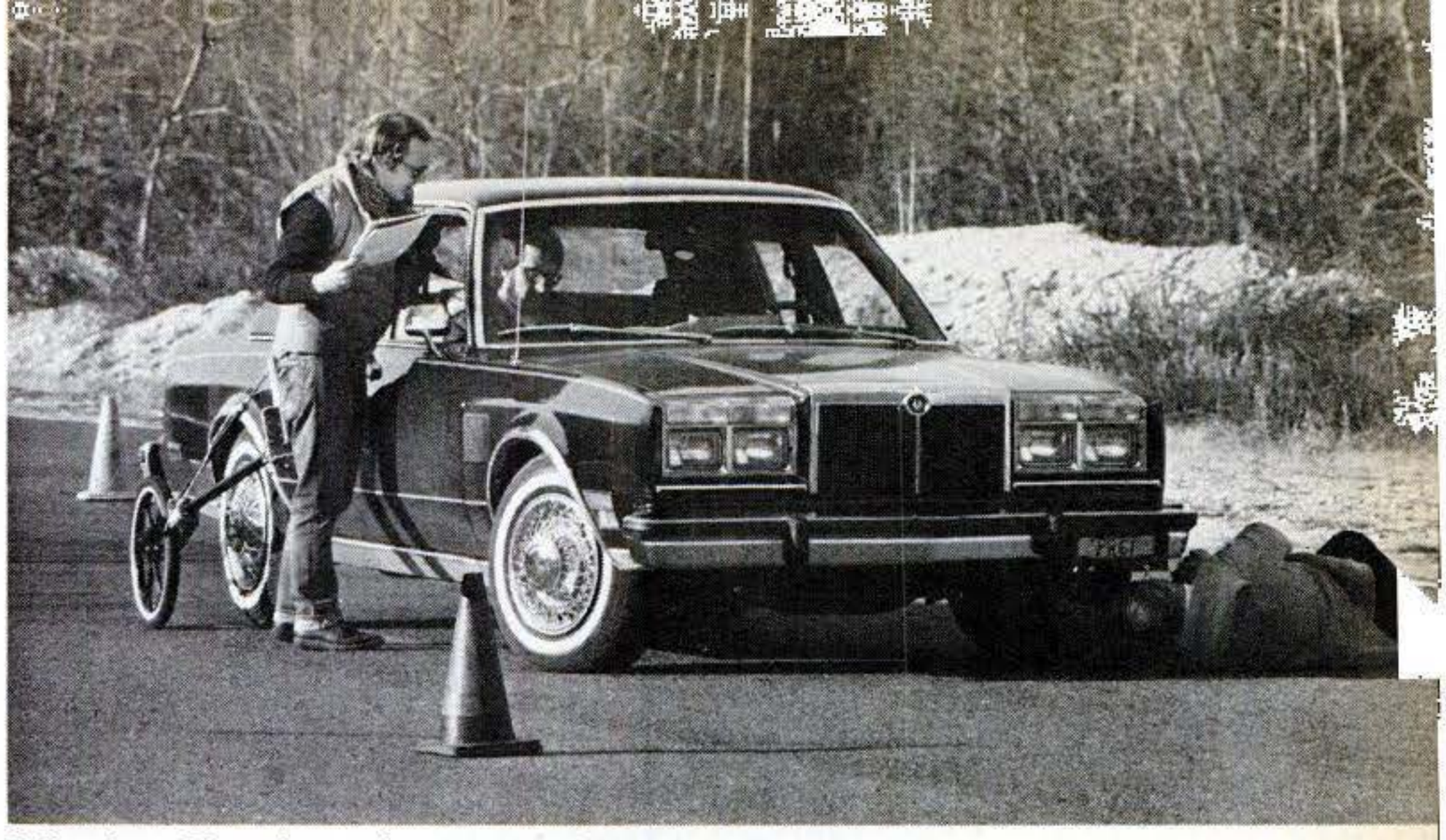
turbo-diesel. (Note: the 528i was damaged during testing and we were unable to perform our own tests for fuel economy and maneuverability.)

Cadillac Seville Eleganté

Seville is completely restyled for 1980 and now shares major assemblies with Eldorado, Toronado, and Riviera. The most obvious difference is its controversial trunk. Whether or not you like the styling depends on your tastes, but we found the trunk's interior dimensions well balanced, with enough capacity to hold average loads—due to the extra room provided by the independent rear suspension.

The passenger compartment is spacious and every bit as posh as you'd expect in Cadillac's prestige model. The seats are comfortable up to a point, but after about 20 minutes you become aware of the lack of lumbar support. Driving position is good, and is helped considerably by a tilt/telescopic steering wheel. Rear headroom is improved over '79, and rear legroom is the best of the group.

Seville's standard engine is the Oldsmobile-built 350-cu.-in. V8 diesel. It starts quickly in cold weather, runs with relatively little vibration or discernible noise inside the car, and provides the second-best economy in all of our observed-mpg categories.



Following 60-mph panic stop, author Dunne checks brake temperature (right), while assistant Ed Moslander checks computer data with author Jacobs (in car).

The Cadillac's biggest drawback, though, can also be tied to the engine: The car is slow, with zero-to-60-mph acceleration averaging 22.6 seconds. Handling and maneuverability were below the rest of the cars. Finally, the diesel's low power rating cuts trailer-towing capacity in half.

When the car had to be driven in a surprise snowstorm, we found trac-

Continued

EPA fuel mileage (mpg)

	BMW 528i	Cadillac Seville	LeBaron Fifth Avenue	Continental Mark VI	Mercedes-Benz 300SD
Highway	32	31	23	25	32
City	24	21	15	15	24
Calif. city	24	*	16	15	24

*Not available in California

Observed fuel mileage
(steady-state mpg)

35 mph	**	28.5	24.1	26.0	37.0
45 mph	**	30.3	22.7	23.0	35.5
55 mph	**	26.3	19.6	20.7	31.7

**Damaged, could not complete testing

New from Stewart-Warner **mini-panel**

The world's smallest instrument panel alerts you to car problems before they cause costly damage.

Mini-Panel is the miniaturized early warning system that helps you spot problems that develop while you drive. (Unlike traditional warning lights that don't go on until it's too late.) Catch those problems early, and you'll save yourself a lot of grief, as well as expense.

Each gauge serves an important function, enabling you to monitor electrical, cooling, and oil pressure systems at a glance.

Mini-Panel is so compact you can mount it on top of your dashboard—without obstructing your view of the road.

It's easy to install,* with no drilling or bolting. No unsightly wires, so you have a professional-looking installation.

You'll find Mini-Panel at auto supply stores and the automotive section of leading retail stores.

*Mini-Panel fits U.S. made AMC, Chrysler, Ford and GM vehicles; adapters are available for most imports.

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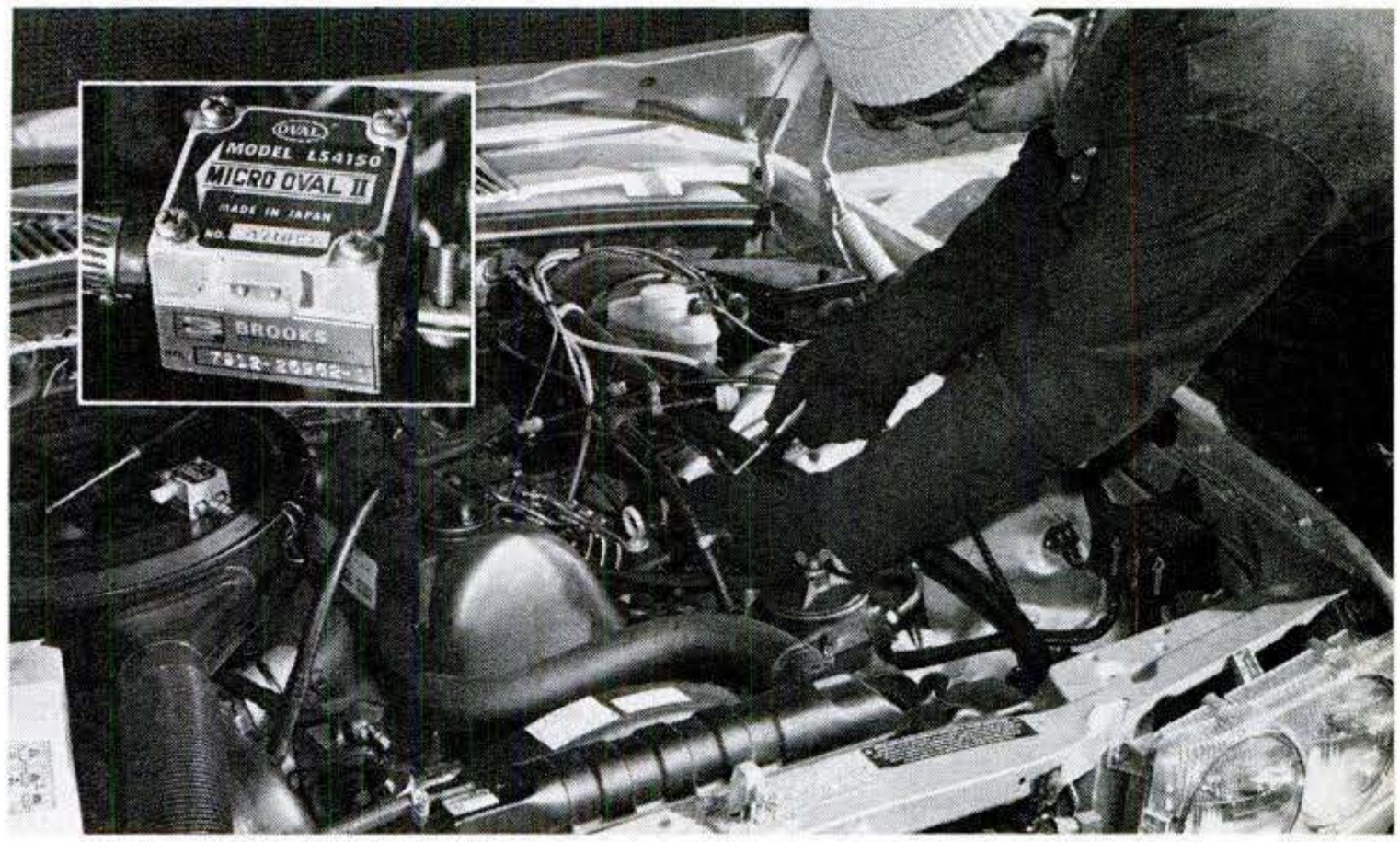
Radical styling of Seville's rear end has aroused much controversy. Unusual shape doesn't prevent trunk from being reasonably roomy, or from accepting bulky items.

Confusing variety of controls on Mark VI's electronically operated radio detracts from an otherwise pleasing unit. Long row of buttons above radio controls on-board computer system.

tion to be surprisingly low, with the tires (non-snow) slipping all too easily. In addition, even low pedal pressures couldn't prevent rear-brake lockup, which was followed by the car's slowly trying to swap ends.

Our Seville was not free of rattles or squeaks, and was prone to clunking of the pedestal-type console on rough roads. The ride on smooth pavement was pleasant, but deteriorated appreciably on rough roads, with the car wallowing on undulating pavement as though running on worn shocks.

As with all of the other cars, fit and finish inside and out are excellent. The push-button climate-control heater/air conditioner was the best in the group. The AM/FM stereo, which showed no fluttering or wavering, even in the canyons of Manhattan, was also of high quality.



Fuel economy is measured using precision flow meters (inset). One monitors fuel-system demand while another checks any return flow to fuel tank.

LeBaron Fifth Avenue

This is a restyling year for LeBaron, and under the pleasing new skin is the Aspen/Volare chassis we've grown accustomed to seeing. The Fifth Avenue edition is the new, ultraplush, top-of-the-line variant. A distinctive roof sets it apart from other LeBarons. Inside, luxurious appointments make it a stronger competitor of Cadillac and Lincoln-Continental. Soft, plush materials cover virtually every surface, including the windshield posts. In addition, the car has the most front headroom in the bunch. On the outside, a padded vinyl half roof adds a distinctive touch, and is set off by a stainless-steel band and electroluminescent panels.

Like the others, the LeBaron has a good driving position and feels quite spacious. The luxurious seats can quickly become uncomfortable for some people, however, due to below-par shaping of the otherwise fine padding. (Fifth Avenues were not in production when we tested this "pilot" model, which had many handmade pieces. The situation may have been resolved in production.)

Handling and maneuverability at the track were both surprisingly good, and the car tied for fastest honors in both tests. On the road, the LeBaron did almost as well, with a pleasant ride on smooth surfaces. On washboard surfaces such as Manhattan's Henry Hudson Parkway, though, its shared Aspen/Volare suspension let ride quality down a bit.

The Fifth Avenue has the lowest EPA economy ratings in this group, but they are quite close to the Mark VI's. In our fuel tests, however, LeBaron delivered similar gas mileage, at both 45 and 55 mph, to that of the Mark VI, which had a four-speed overdrive transmission.

We found the Fifth Avenue to be plush, good-looking, and pleasant to drive, especially with its reduced interior noise. At half the price of the Seville and Mark VI, it would seem quite a bargain.

Lincoln-Continental Mark VI

Despite shrinking 14 inches this year, the redesigned Mark VI is still big—nearly 10 inches longer than Seville, LeBaron, and Mercedes, and 26 inches longer than the BMW. The Mark's new design retains much of the earlier cars' flavor, and is as richly appointed. The interior is plush, and the seats are expensively upholstered and comfortable.

The new Lincoln was second fastest in acceleration, despite being second heaviest. Its high-speed handling speed was second slowest (equal to last year's model), but the low-speed maneuverability was improved a whopping 4.6 mph. In our hot-brake test, though, its stopping distance was

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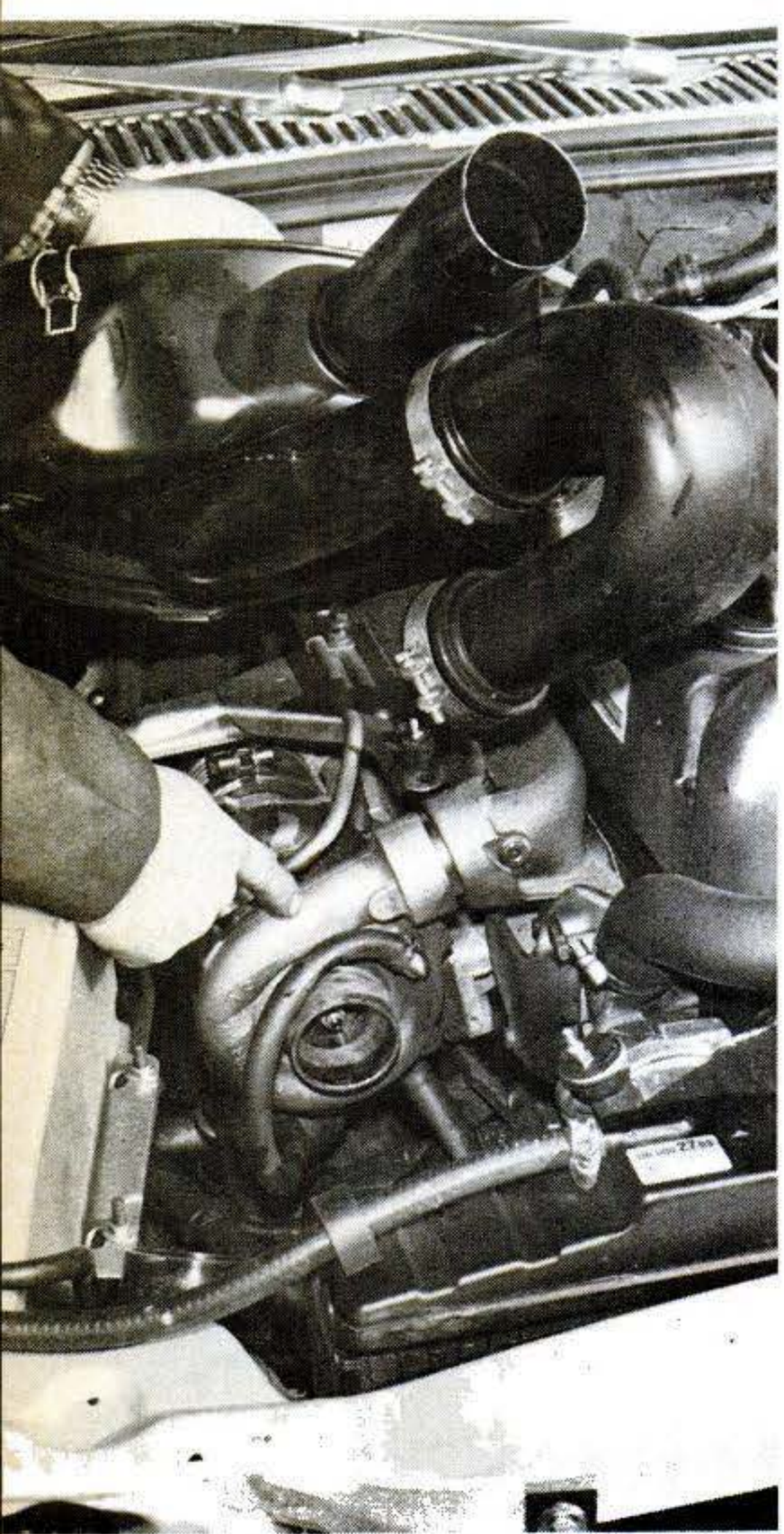
Noise levels are checked at 30 and 60 mph on smooth pavement, 30 mph on rough dirt surface. Noise meter is placed midway between driver and passenger.



Mercedes' small turbocharger is tucked alongside engine. It provides ample power on demand, yet allows engine to be very economical in normal driving.

194 feet—poor, and bordering on a "very poor" rating. We did not, however, experience the engine-stalling condition we found in our recent test of the Ford LTD [PS, Apr.] when the brakes are suddenly applied in a simulated high-speed panic stop. The four-speed automatic-overdrive transmission performed flawlessly in this test. That was surprising, since the Mark VI has slightly less rear weight bias, which should make rear-wheel lockup somewhat easier.

A Lincoln spokesman told us that the transmission in our car was not altered for this test, and is the same as you would get in a new-car showroom. Earlier testing on other four-speed Lincolns, however, produced stalling similar to the LTD's. Apparently, the condition varies from car to car.

Sometimes small things bedevil a good car, and we noted several minor irritants about our Mark VI. First was the disorganized appearance, to our eyes, of the dash. The array of sliding controls, push buttons, rocker- and flip-switches, and knobs detracts from the presence of the outstanding electronic instrumentation, which has large, bright, highly legible displays. Ford's practice of putting the horn button on the end of the turn-signal stalk takes some getting used to, since it's not where you'd normally reach. (The move was made in anticipation of putting an air bag in the steering-wheel hub.) Another quirk: Lincolns have small, inexpensive-looking steering wheels, similar to those used on many cheaper cars. The wheel's rim blocks part of the instrument-panel readout. Finally, the Mark VI was the noisiest car in the group, tied with the Mercedes turbo-diesel.

Highway fuel economy is improved 35 percent over '79, and ride quality is good, although there is a greater tendency toward pitching on rough roads than in the Seville. An interesting plus for the Mark VI is the optional keyless entry system. It's fairly expensive, but it effectively counters the locked-in-keys situations common on cars with power door locks.

Mercedes-Benz 300SD

If you like paradoxes, consider this: The most expensive car in the test turned out to be by far the most economical with fuel. (See economy-test results for comparison.) Furthermore, it proved surprisingly quick in acceleration and tied for top speed in both handling and maneuverability. Its five-cylinder, three-liter turbocharged diesel engine has only a little over half the displacement of the Seville's, yet it soundly trounced the Cadillac in acceleration tests and was capable of running with the gasoline-powered cars.

It's the turbocharger that really makes the difference, of course, allowing the engine to cruise along at high economy until power is needed, then pumping it out (with a corresponding leap in fuel consumption). So the 300SD offers the best of both worlds: power or fuel economy, whichever you need.

The car's interior is typical Mercedes: businesslike and functionally comfortable. Seats are firm yet comfortable. The spacious interior's dimensions offer the most hip room front and rear, as well as the most rear knee room.

Driving position is excellent, and the highly legible instrumentation is clustered in front of the steering wheel, with a row of warning lights underneath. Steering is precise and responsive, with a nice amount of "road feel." The ride is firm yet not harsh, and is well controlled even on rough roads.

One engine improvement is worth noting. The new, quick-start glow plugs require only a 10-second warm-up before starting the diesel engine on the coldest mornings, and the engine is responsive, flexible, and smooth running. The transmission, however, sometimes shifted a little sloppily when cold, although it settled down almost immediately.

Body construction is solid, and the overall fit, workmanship, and finish are of high quality, just as you'd expect in a $32,000 car. Getting such high fuel economy is an unexpected bonus. PS

For specs and test results, turn page

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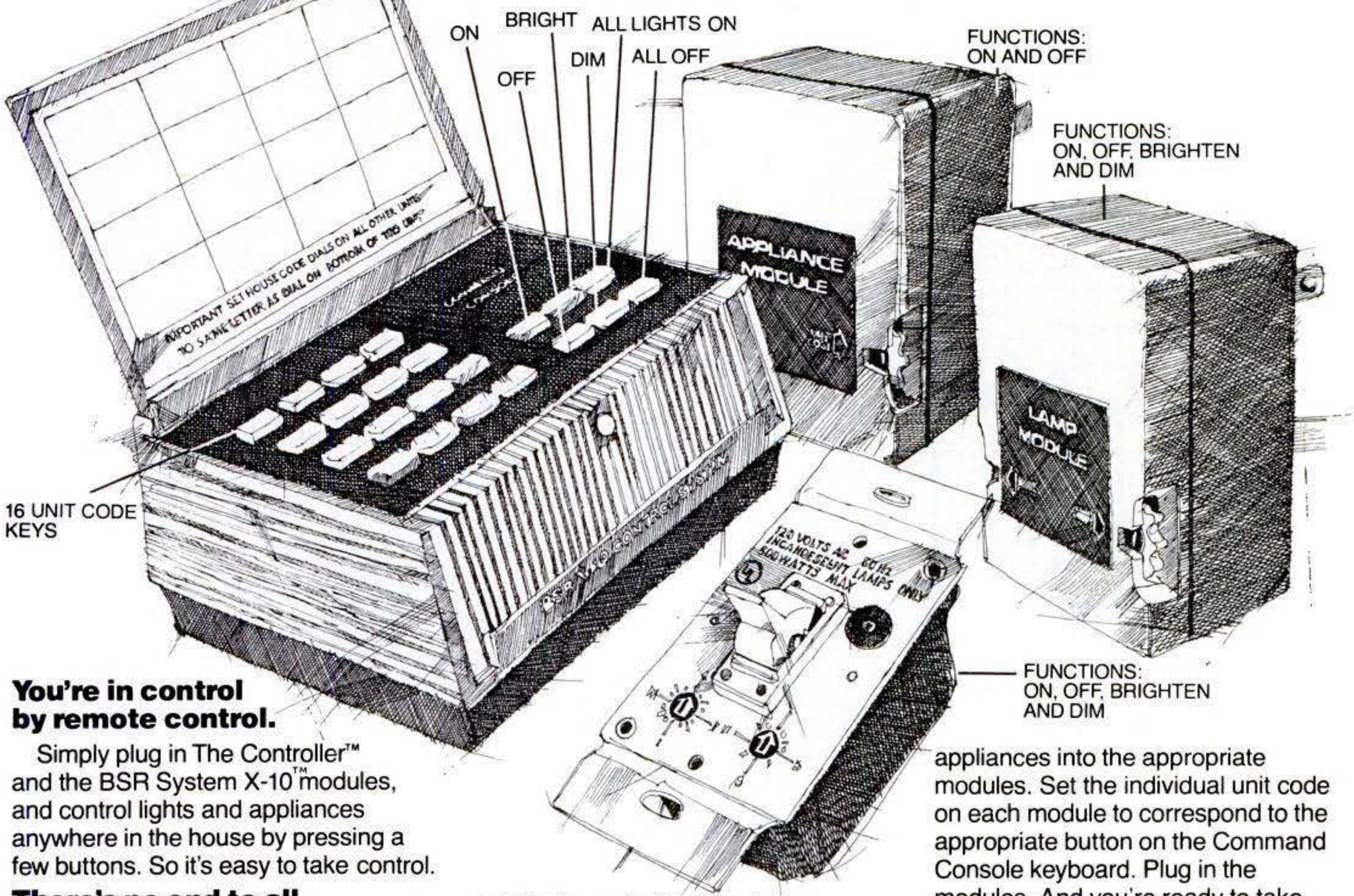
An in-depth look at the only "plug-in" remote control system you'll ever need for your home.



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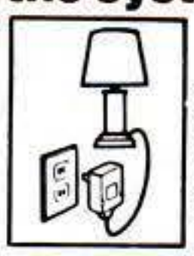
And when it's time to turn in, just push a button and turn everything off. And sleep soundly. But, if you hear a strange noise in the middle of the night, you can press a button to turn on all the lights and scare the daylights out of an intruder.

The Controller is designed to control every room in the house.

By pressing the buttons on the Command Console keyboard, command signals are transmitted over existing household wiring to the module of your choice. The Lamp Module turns on, off or dims any incandescent lamp up to 300 watts. The Appliance Module turns appliances like TVs, window fans or stereos on and off. And the Wall Switch Module is designed to turn on, off or dim any light or lamp up to 500 watts normally operated by a wall switch.

There's even a Cordless Controller that transmits signals to an Ultrasonic Command Console from up to 30 feet away. So there's plenty of control for everyone.

Simplicity is built into the system.



No special wiring is needed. Simply plug The Controller Command Console into any wall outlet in any room of the house. Set your personal house code on the console. Then plug your lamps and appliances into the appropriate modules. Set the individual unit code on each module to correspond to the appropriate button on the Command Console keyboard. Plug in the modules. And you're ready to take control.

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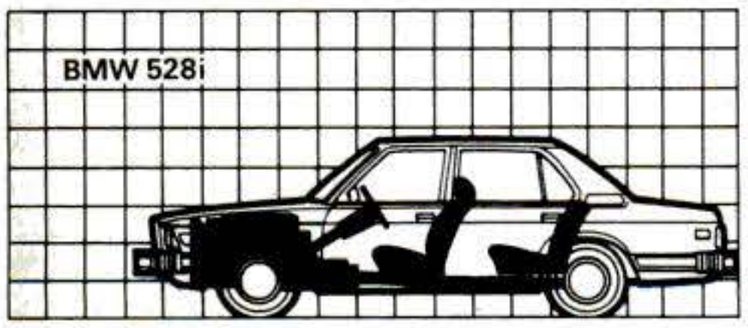

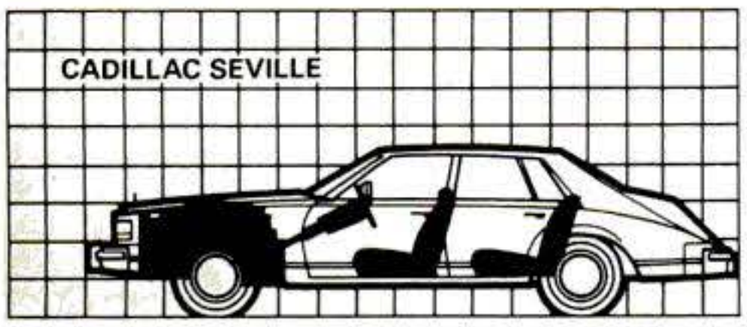

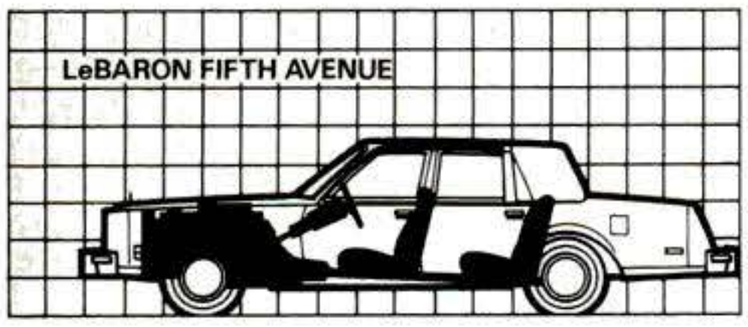

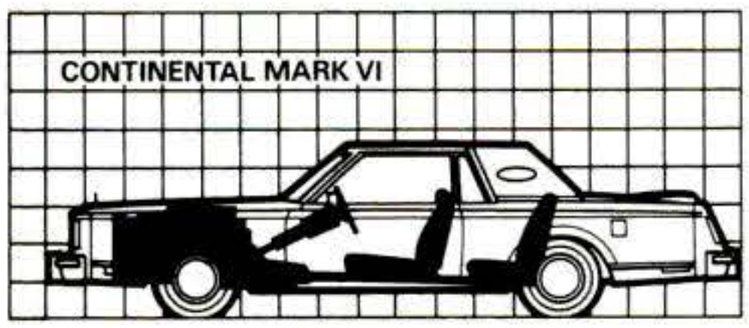

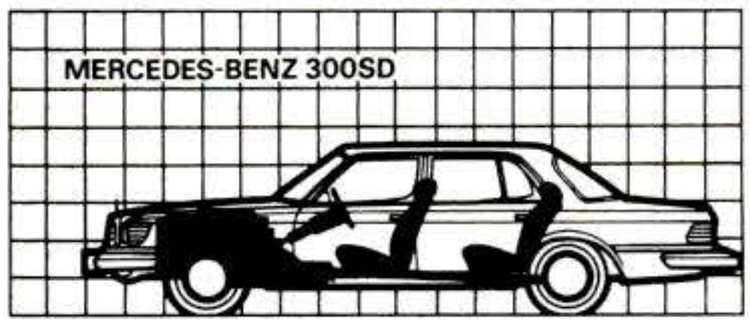

BMW 528i, Cadillac Seville, Chrysler LeBaron Fifth Avenue, Lincoln-Continental Mark VI, and Mercedes-Benz 300 SD: dimensions, specs, and test results

	BMW 528i	Cadillac Seville	LeBaron Fifth Avenue	Continental Mark VI	Mercedes-Benz 300SD
DIMENSIONS (inches)					
Wheelbase	103.8	114.0	112.7	114.3	112.8
Overall length	190.0	205.5	205.2	216.0	205.5
Overall height	55.9	55.2	55.3	55.4	56.1
Overall width	67.2	71.4	72.6	78.1	73.6
Track, F R	56.0 57.9	59.3 60.6	60.0 59.5	62.2 62.0	59.9 59.3
Ground clearance	n.a.	5.5	7.6	6.5	8.0
Front head room	35.0	38.1	39.3	38.0	38.4
Front hip room	54.0	51.4	56.8	56.5	57.5
Front leg room	44.0	42.8	42.4	42.1	41.7
Rear head room	32.0	37.3	37.7	37.8	37.1
Rear hip room	54.0	54.1	56.6	57.0	59.5
Rear leg room (min.)	34.0	39.4	37.4	38.0	34.4
Rear knee room (min.)	−1.0	3.1	1.2	2.3	4.0
Couple distance	26.0	34.8	33.8	33.5	34.0
SPECIFICATIONS					
Engine type	SOHC I6	V8	V8	V8	I5 turbo
Displacement (cu. in. L)	170/2.8	350 5.7	318 5.2	351 5.8	183 3.0
Compression ratio	8.2:1	22.5:1	8.5:1	8.3:1	21.5:1
Carburetion	F.I	F.I	2-bbl.	2-bbl. variable venturi	F.I.
Net hp @ rpm	169 @ 5500	125 @ 3600	120 @ 3600	140 @ 3400	120 @ 4350
Net torque @ rpm	170 @ 4500	225 @ 1600	245 @ 1600	265 @ 2000	170 @ 2400
Transmission	Three-speed automatic	Three-speed automatic	Three-speed automatic	Four-speed overdrive automatic	Four-speed automatic
Axle ratio	3.45:1	2.41:1	2.47:1	2.73:1	3.07:1
Tire make	Continental	Goodyear	Goodyear	Michelin	Pirelli
Tire type	Contact TS730 radial	Polysteel radial	Polysteel radial	XA steel-belted radial	Cinturato
Tire size	205 70SR14	P205 75R15	P205 75R15	P205 75R15	185HR14
Steering	Recirculating ball, power	Recirculating ball, power	Recirculating ball, power	Recirculating ball, power	Recirculating ball, power
Overall steering ratio	16.9:1	Variable, 15.0–13.0:1	18.7:1	16.4:1	14.0:1
Turns, lock to lock	3.5	3.0	3.5	3.4	2.7
Turn diameter (ft.)	31.5	38.39	39.5	40.0	38.0
Front suspension	Independent, MacPherson struts	Independent, single lower control arms, torsion bars	Independent, lateral nonparallel control arms, torsion bars	Independent, single lower control arms, coil springs	Independent, double A-arms, coil springs
Rear suspension	Independent, MacPherson struts	Independent, trailing arms	Solid axle, Hotchkiss, semi-elliptical leaf springs	Solid axle, four control links, coil springs	Independent, diagonal-pivot axle, coil springs
Front stabilizer-bar diameter (in.)	n.a.	1.10	1.12	0.97	n.a.
Rear stabilizer-bar diameter (in.)	n.a.	0.87	None	None	n.a.
Trailer towing (max. lbs.)	n.a.	1000	2000	6000	3300
Trailer tongue weight (max. lbs.)	n.a.	100	200	750	300
Brakes	Disc disc, power	Disc disc, power	Disc drum, power	Disc drum, power	Disc disc, power
Brake swept area (sq. in.)	n.a.	396.0	355.24	385.8	456.9
Fuel tank (gal.)	15.3	23.0	18.0	20.0	21.7
Trunk space (cu. ft.)	21.9	14.5	15.6	22.4	15.0
Liftover height (in.)	35.0	28.1	28.5	23.1	37.0
Curb weight (lbs.)	3210	4185	3472	4046	3785
F R weight distribution (%)	56 44	60 40	56 44	57 43	55 45
Basic price	$20,150	$19,978	$6888	$15,701	$30,632
Price as tested	$22,585	$23,087	n.a.	$19,107	$32,460
Major options on test car	Auto. trans. $705, leather upholstery $1030, sunroof $700	Elegante package $2934, theft-deterrent system $153	Fifth Avenue package $2000 (est.)	Cartier option $2191, 351 engine $160, keyless entry $253, cruise control $149, reclining power seats $139, premium sound system $160, rear defroster $132	Sunroof $745, metallic paint $728, AM-FM stereo tape $355
TEST RESULTS					
Acceleration (sec.)					
0–60 mph	10.6	22.6	13.7	12.1	13.6
25–70 mph	10.9	28.0	15.5	14.2	15.5
Brake test (cool) 60–0 mph					
Stopping distance (ft.)	169*	168	178	178	167
Pedal pressure (lbs.)	80	45	135	120	140
Disc temperature (°F)	202	251	205	143	141
Brake test (hot) 60–0 mph					
Stopping distance (ft.)	151*	179	172	194	179
Pedal pressure (lbs.)	100	30	128	155	141
Disc temperature (°F)	499	547	580	515	672
Interior noise @ 60 mph (dBA)	65	67	67	71	71
Handling test (mph)	62.4	53.0	62.4	56.3	62.4
Maneuverability test (mph)	**	26.8	28.1	27.6	28.1

TEST CONDITIONS: Ambient temperature, 38° F; relative humidity, 60 percent; barometric pressure, 29.9 inches Hg
*Measured manually **Damaged, could not complete testing

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	BMW 528i	Cadillac Seville	LeBaron Fifth Avenue	Continental Mark VI	Mercedes 300SD
Checking fluid levels:					
Battery	5	5	5	5	5
Master cylinder	5	5	4	4	5
Windshield washer	5	5	5	5	5
Engine oil	3	3	4	2	4
Coolant	5	5	5	5	5
Checking the engine:					
Spark plugs	3	n.a.	4	2	n.a.
Distributor	4	n.a.	2	3	n.a.
Carb adjustment	F.I.	F.I.	3	*	F.I.
Oil filter	3	1	3	2	3
Oil fill	3	3	2	2	4
Replacing hoses:					
Upper radiator hose	5	5	5	5	5
Lower radiator hose	3	2	2	1	3
Heater hoses	2	3	3	3	2
Changing bulbs:					
Headlights	3	3	3	5	3
Taillights	3	3	3	3	3
Front running lights	3	3	3	3	3
Front parking lights	3	3	3	3	3
Front directionals	3	3	3	3	3
Rear directionals	3	3	3	3	3
Rear running lights	3	3	3	3	3
Checking fuses	5	3	4	4	4
Spare-tire accessibility	3	3	3	3	3
Changing belts	4	2	3	3	3

*Sealed

Performance comparison with selected 1980 and earlier models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1979 Cadillac Eldorado V8	14	11.5	183	58.2	27.6	64
1979 Lincoln-Continental Mark V V8	12	14.3	154	56.3	23.0	68
1979 Mercedes-Benz 450 SEL V8	12	12.9	163	60.0	27.6	69
1979 BMW 633 CSi I6	13	10.3	140	60.0	29.1	68
1979 Jaguar XJ-12L V12	10	10.0	159	62.4	28.6	67
1980 Ford LTD V8	16	12.8	183	59.0	26.6	64
1980 Chevrolet Caprice V8	17	13.0	167	61.0	26.9	65
1979 Oldsmobile Toronado V8 diesel	16	17.8	134	60.0	25.3	68

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New workers on the assembly line: robots that think

No longer automatons, the new generation of robots can see, touch, and make decisions

By JIM SCHEFTER

The hulk of a car body moves slowly into position, riding the automatic assembly line through an empty, workerless area. Suddenly hordes of sleek, smoothly articulated arms swing out, surrounding the car. They dip forward with noisy whines, pneumatic air bursts, and sharp explosions from fiery welders. Bright hot sparks arc out from a half dozen points as the sizzling welders burn metal to metal.

In moments, the swarming machines fall back. There is a last sigh of escaping air, then only the sound of the car inching forward to another assembly station. Still there are no people; the team of sensitive robots waits silently for the next car.

That eerie scene, intelligent machines going independently about their business, is repeated thousands of times each day at Ford, General Motors, and Chrysler. It's even more common in Japan, where sharp in-

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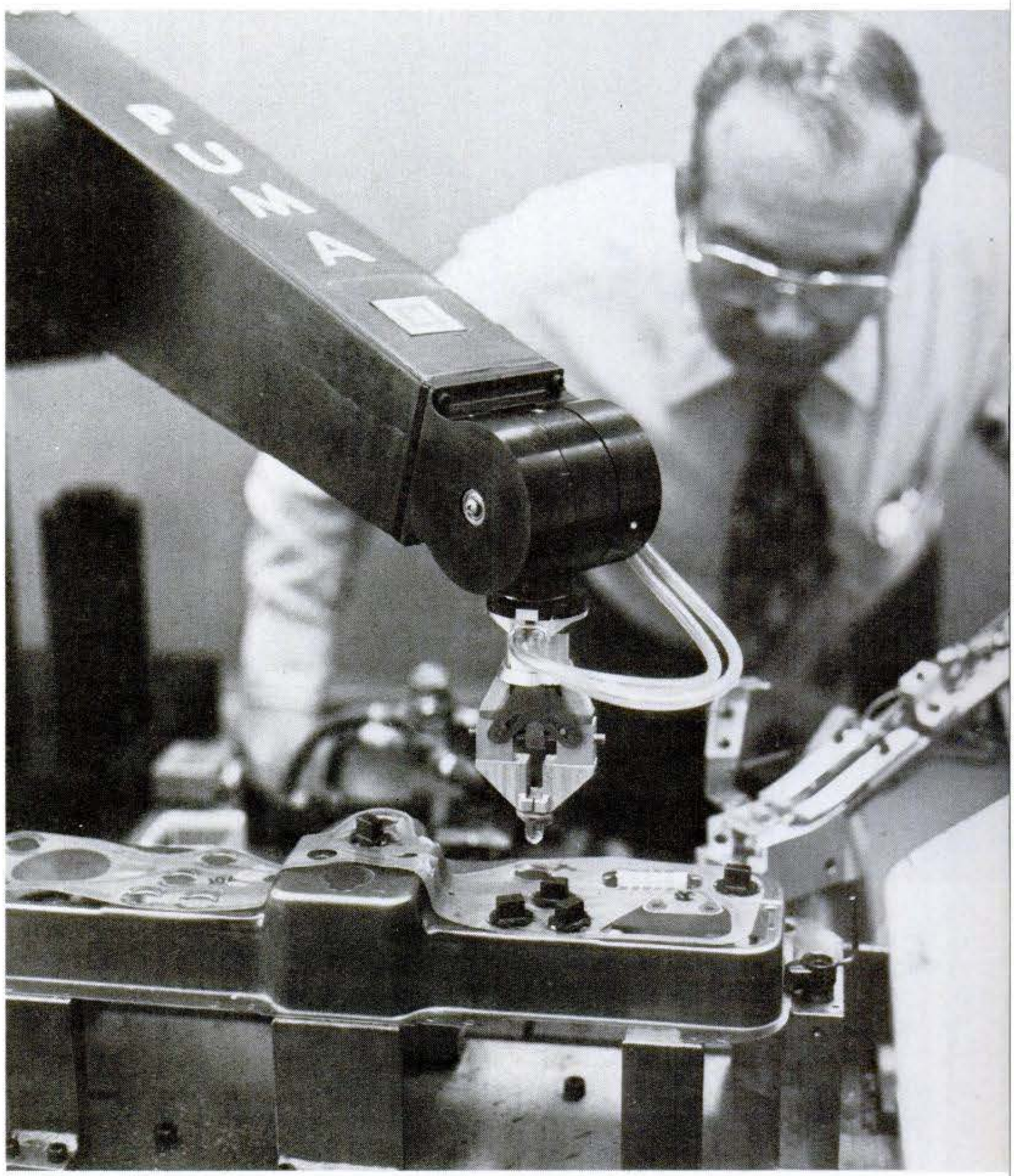

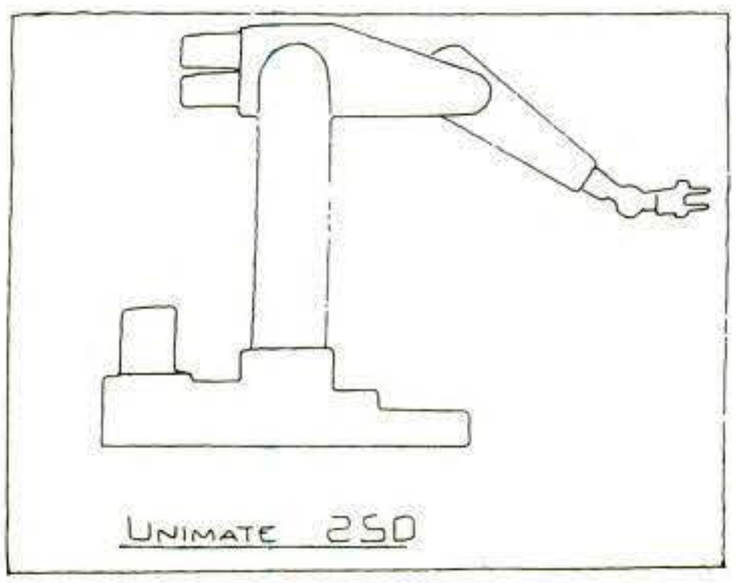

Inserting a light bulb into the back of a dashboard instrument panel, an advanced PUMA robot first positions the bulb precisely, then spins it into place. This lab demonstration illustrates a valuable attribute of the Unimate robot: positioning accuracy. Today's best industrial robots have a positioning accuracy of about 0.05 in. (1.27 mm). PUMA is 25 times more accurate. The "self-portrait" at left demonstrates this: The robot drew it repeatedly without one false squiggle.

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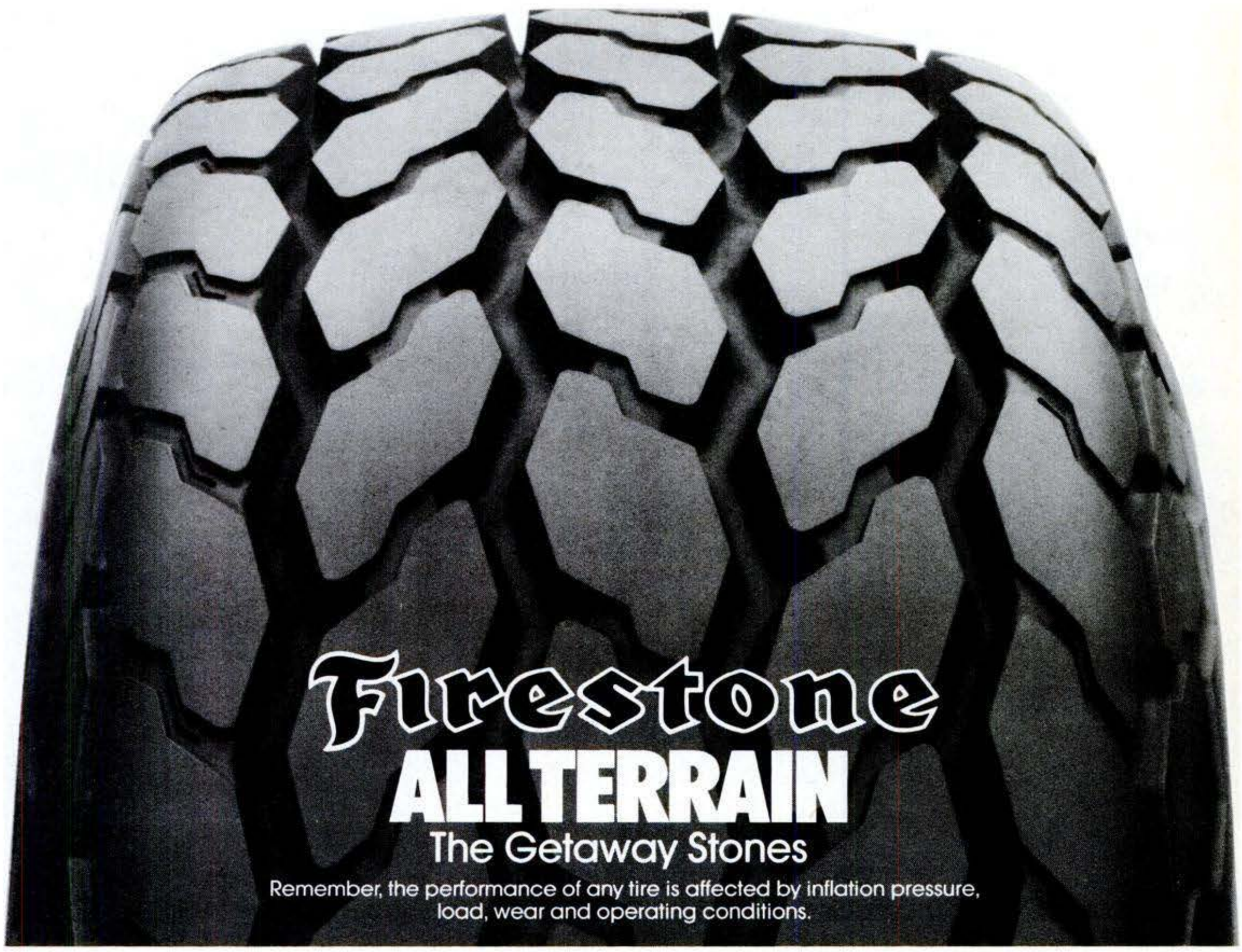

Remember, the performance of any tire is affected by inflation pressure, load, wear and operating conditions.

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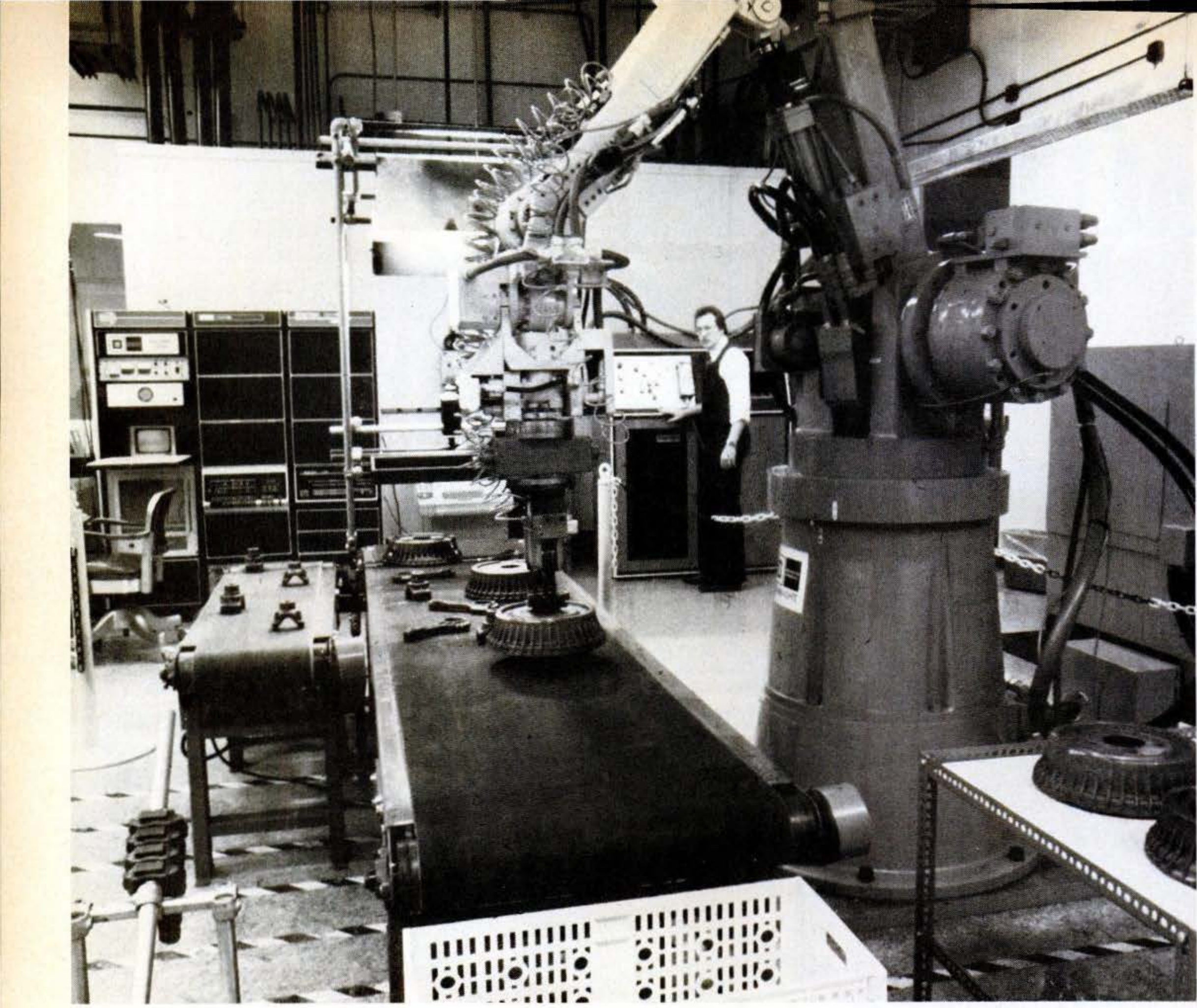
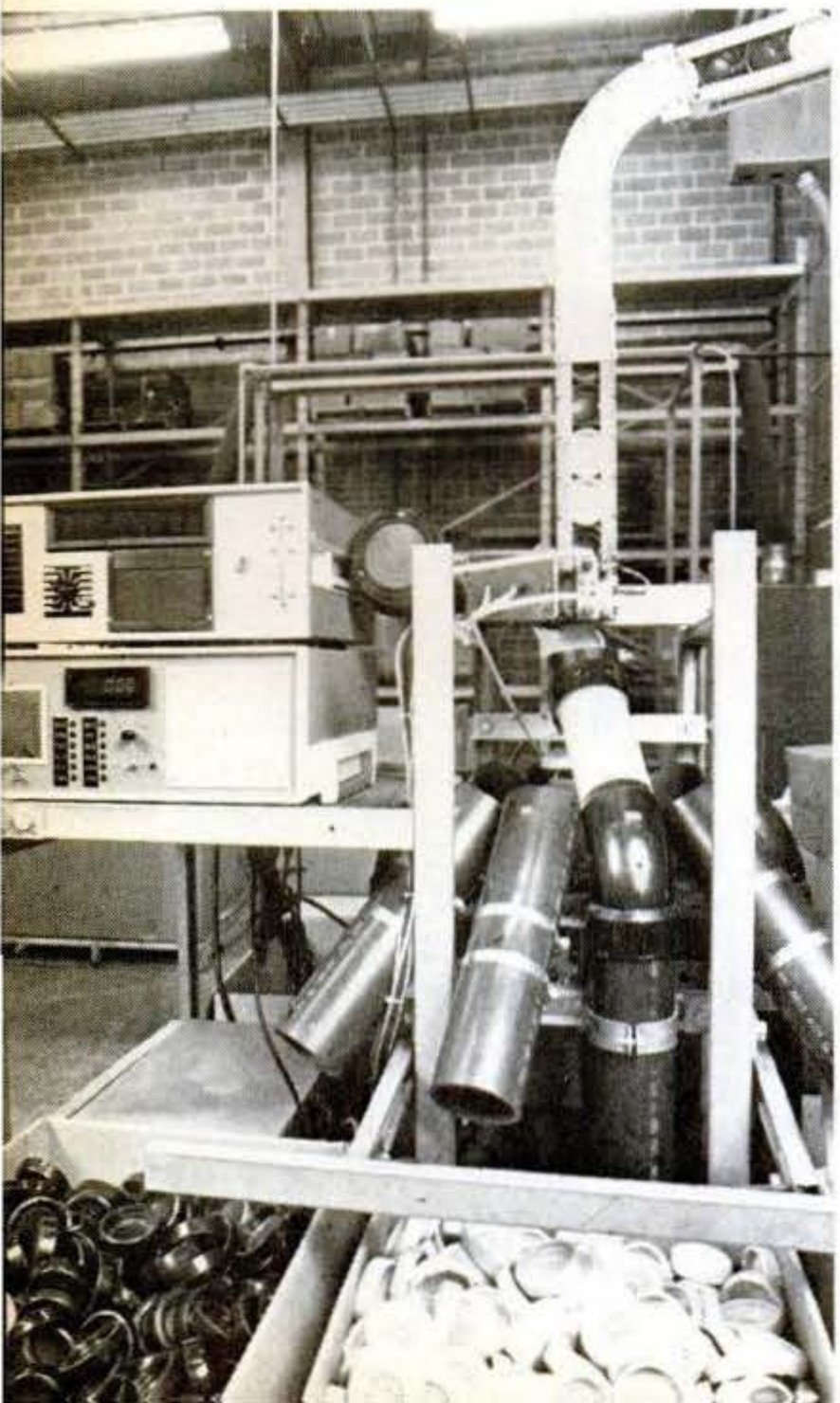
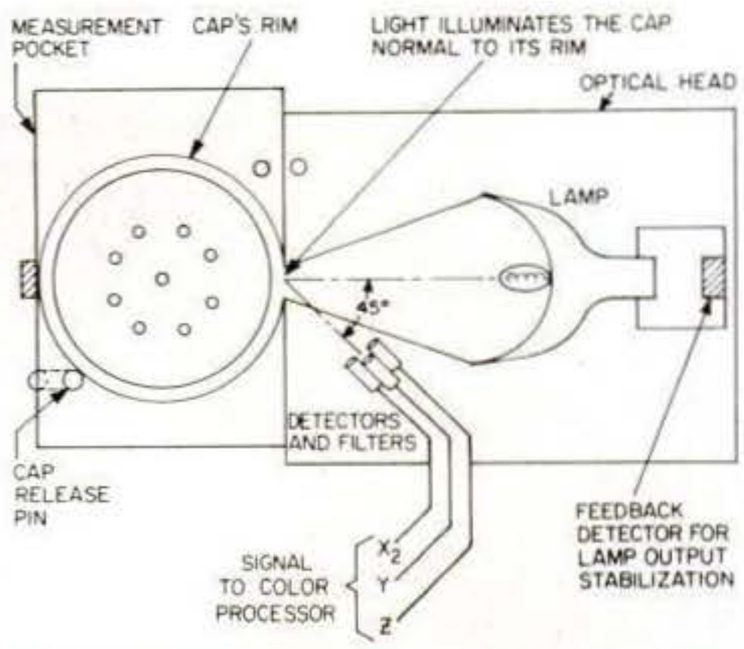


Spotting a brake drum, GM's seeing robot lifts it off conveyor for stacking with others (right foreground). A sharp line of light (visible slicing across another brake drum at rear) aids camera eye (on vertical bar) that feeds shape and position data to robot's computer brain. The "smart" robot also slides connecting rods onto racks (left foreground) and positions two sizes of universal joint on adjacent conveyor.





Color-sorting robot (left) zips 6500 telephone receiver caps an hour into proper bins. Robot's optical head (above) has three photodiodes capped with primary filters to simulate human color reception. A microprocessor analyzes the color signals, then directs the robot to swing its rotating chute into line with one of 12 different color bins. The Western Electric robot is 99.9 percent accurate.

creases in productivity at Datsun are the direct result of applying advanced robotics to assembly-line operations. Toyota is not far behind.

The fact is that a new generation of robots is exploding onto the industrial scene, taking over in ways few companies imagined short years ago.

"Industrial robotics used to be more like automation," said GM's Ed Kavetsky. "The machines just repeated the same motions. But now we're using general-purpose digital computers to get true robotics."

A robot is a device that can be programmed to perform a variety of mechanical tasks—unlike a piece of automated equipment, which is designed to do only one kind of job.

The oldest industrial robots are basically bulky, limited-motion devices controlled by very simple, non-computer software—a series of wires

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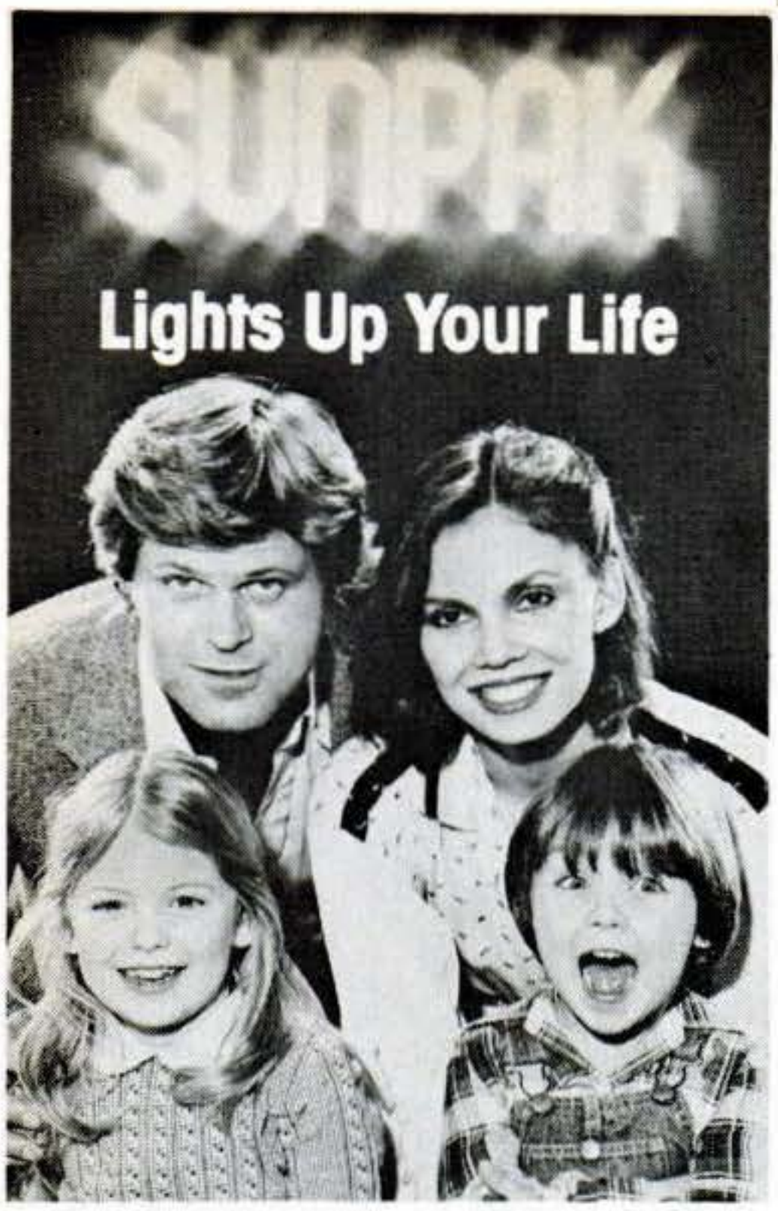

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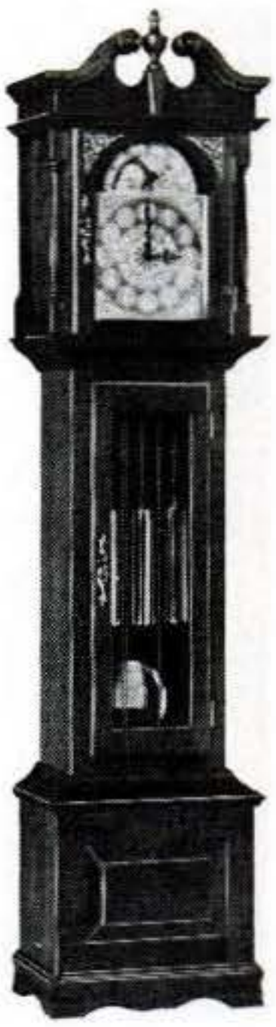

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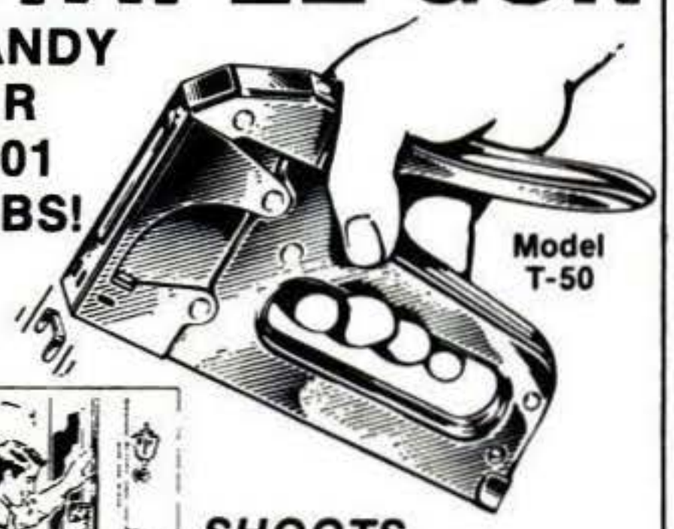

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Robots that think

[*Continued*]

that's plugged into a circuit board.

More modern robots are controlled by sophisticated computers, with the capacity to memorize a lengthy, complex sequence of motions—those needed to spot-weld, for example.

These robots can perform only the programmed sequence. If a part isn't in the right place at the right time, the robot ignores it, or maybe crushes it by mistake. And reprogramming these robots is a laborious process: An operator must literally lead the robot step by step through the new job.

But the newest robots have moved far beyond earlier automatons. No longer confined to lockstep tasks, the best of them can see, touch, and make intelligent decisions.

Capitalist tools

Robotics has become big business in recent years, both in terms of research and in commercial applications.

- Matushita Electric Co. in Japan reported a *2900 percent* improvement in productivity when it substituted a computer, a robot team, and four human monitors for 120 workers manufacturing vacuum cleaners.
- Western Electric developed an intelligent machine to sort telephone parts by color. First of the units went into operation recently at the company's Atlanta service center. Sorting speeds more than tripled, while accuracy improved nearly 15 percent.
- Texas Instruments has designed and built "seeing" robots that work on the company's calculator assembly lines in Lubbock, Tex. IBM uses similar vision-assisted robots for making printed circuit boards and testing components.
- Lockheed-Georgia has a pilot program with two robots working off a single computerized control unit to assemble an internal part of the C-130 Hercules cargo aircraft. That part contains 11 separate components and 154 rivets, all brought together and fastened without human aid.
- Battelle's Pacific Northwest Laboratories has demonstrated a micromouse, a little robot using infrared detectors for eyes, four microprocessors for intelligence and memory, and two more storage chips for permanent programming. The "mouse" learns a maze by trial and error, mastering it completely by the third run. Battelle thinks the robot could run shuttles in underground mines or control irrigation systems.

One of the most advanced research efforts under way is one-third complete at Westinghouse Electric's R&D

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facility in Pittsburgh. The company, working under a National Science Foundation grant, is developing a robotic batch-manufacturing assembly line that will produce fractional-horsepower electric motors.

Batch manufacturing—assembling components to make a relatively small number of finished products—makes up about 75 percent of U.S. manufacturing. Automated assembly lines are impractical for batch manufacturing because many products have a variety of styles that require slight but frequent changes in the assembly process. If Westinghouse can develop a robot-populated line adaptable to a variety of products (see diagram), manufacturing efficiencies will soar.

While such research programs and one-by-one industrial applications advance future robotic technology, a number of companies are selling today's robots as fast as they can build them. Heavy industrial robots are produced by Cincinnati Milacron, Prab Conveyors, and others. But the clear leader in sales and technology is Unimation, based in Danbury, Conn.

More than half of all industrial robots sold in the U.S. and most sold in Japan are Unimation machines: either large Unimates or the sleek new PUMA (Programmable Universal Machine for Assembly).

The large Unimate robots handle heavy-duty tasks—automotive welding, spray painting, lifting and moving objects weighing hundreds of pounds. Such machines have been around for about 20 years, evolving from simple units controlled by paper-tape instructional drives into more sophisticated modern electronic systems.

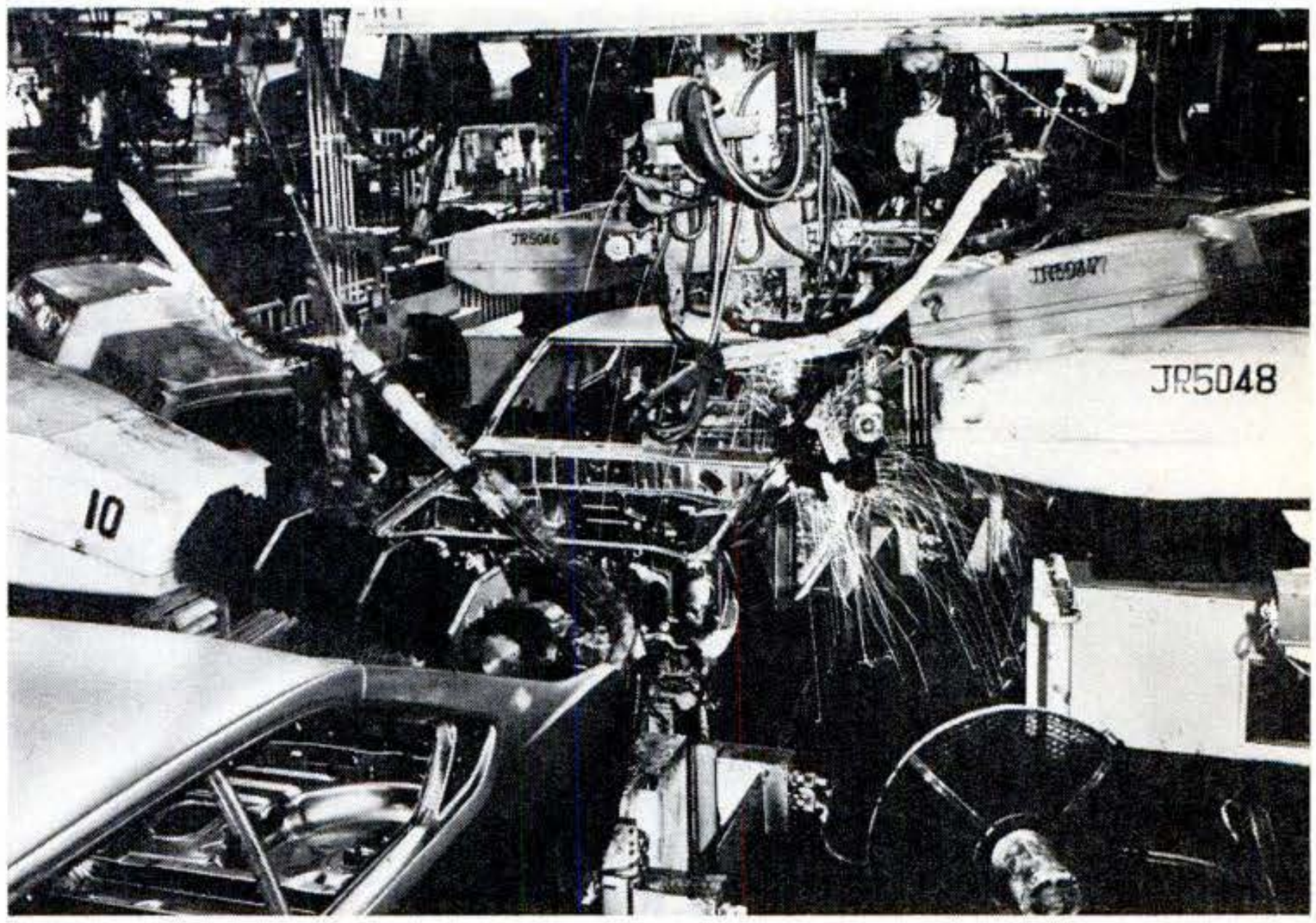
But the real advance is PUMA.

"PUMA is a whole new breed of robot," said Brian Carlisle at Unimation's research laboratory. "It's a computer-controlled smart robot."

It looks much like a human arm mounted on a pedestal; the smaller of two versions is of about human size. The upper arm tapers from the shoulder to the elbow. The forearm tapers further to the wrist. At the end, there's a hand, which can be a gripper, a built-in tool, or almost anything else needed where the work is to be done.

An early PUMA model went to the General Motors Technical Center in Warren, Mich., for vision-development work.

Ed Kavetsky and the GM robotics team have devised a system that makes their PUMA one of the most



Medusa-like arms swing out in a shower of sparks, spot-welding a Datsun frame. Though swift, these older robots can't vary routine—even if car is out of place.

advanced robots in the world. It has vision and decision-making abilities—both provided by three small DEC computers. One sorts out input from a video "eye," one controls PUMA's motion, and one serves as a supervisor, remembering everything needed for automatic operation.

Seeing-eye arm

To develop this advanced system, the GM team analyzed the demands of the automotive assembly line. They started with the fact that automotive components often move down conveyor lines in a mixture. Human workers can pick out the part they need. But that was too complex for a machine. Until now.

The first job was to teach a robot—actually its computer—to recognize specific parts. That meant designing a complex software package to interpret video data. (Cincinnati Milacron did this job.)

"We designed a unique lighting system to help the computer," Kavetsky said. "It doesn't require color contrast, but it sees height so it can pick out a gray part moving on a gray background."

The system uses two bright lights angled down through lenses to form a brilliant line across the conveyor belt. A video camera looks straight down at that line (see photo on a previous page).

As a random mixture of parts crosses the line, the video camera transmits 128 slices of data to the computer. Stored in the computer memory are the exact shapes of five parts—a brake drum, a connecting rod, a wheel, and two sizes of identically shaped universal joints. The video computer sorts through the data and identifies the parts. (If a part is not one of the five in memory, the computer ignores it.)

Five new pieces of data are then transferred to the supervisor computer: part identification, x and y coordinate, angle or orientation, and position on the belt at the moment of crossing the band of light.

To teach PUMA what to do with each part, the team had to stop the conveyor after a part was videotronically identified. Using a sophisticated push-button controller, the GM experts moved PUMA's "hand," one of several that can be attached, to the part and picked it up. Each point or change of direction along the way went into the supervisory computer's memory. Finally, they used the "teach" controller to move the part to its desired location.

"The supervisory computer remembers all this for the 'auto' mode of operation," Kavetsky explained. Once the months of programming were completed, the robot's pickup and delivery motions became infinitely variable, precisely matching the position of randomly placed parts. The supervisory computer does the thinking.

"The robot is instantly retaught to take a new path, maybe one it has never taken before," Kavetsky said.

To prove his point, he dumped a box of mixed parts onto the conveyor. Lights came on. PUMA whirred in an-

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[Continued]

ticipation. Suddenly it acted, moving far faster than any human.

PUMA snatched brake drums, stacking them neatly on a pallet. It threaded connecting rods onto storage shafts. It placed the universal joints on an adjoining conveyor belt, positioning the two sizes at 90-degree orientations. And finally it stacked wheels on the floor.

In an assembly-plant setting, PUMA could take over similar tasks now performed by people. It would work three shifts a day, have no absentee problems, and probably improve production efficiency. GM and other manufacturers are cooperating with unions to protect jobs while still getting such benefits into plants.

Already GM has installed dozens of PUMA's without the vision system in several of its plants. In those applications, precise and consistent placement of parts is required. But the robots are working out well.

According to senior engineer Walter Cwycyshyn, PUMA's are ready to take over a task at a Delco plant in Rochester, N.Y. There the robot will reach into a hot furnace, pull out an electric-motor armature, snap on a commutator ring, apply resin, and put it back for heat curing. Up to now, this tiring and potentially dangerous job has been done by humans using asbestos gloves and tongs.

"Robots are ideal for light assembly operations," Cwycyshyn added. GM also plans to use robots for installing and spinning light bulbs in dashboard panels, stacking and palletizing speaker magnets, and installing screw fasteners. The PUMA robots could work up to three times faster than humans, but GM is holding them back to get more experience.

"If something goes wrong, I want to pull out the robot and put in a human," Cwycyshyn explained. "We couldn't do that if the line moved at triple speed." He added: "Ideally we'd like to see our parts come in a pan, have the robot pick the right part of that jumbled mess, then do something with it."

This may come soon. GM plans to try out the advanced "seeing" PUMA in a plant late this year.

Developing robot language

While GM was teaching PUMA to see, the Unimation team was working on an improved version of the basic advanced model.

The robot took more than two years to develop. Much of the difficulty came in programming its LSI-11 computer

Continued

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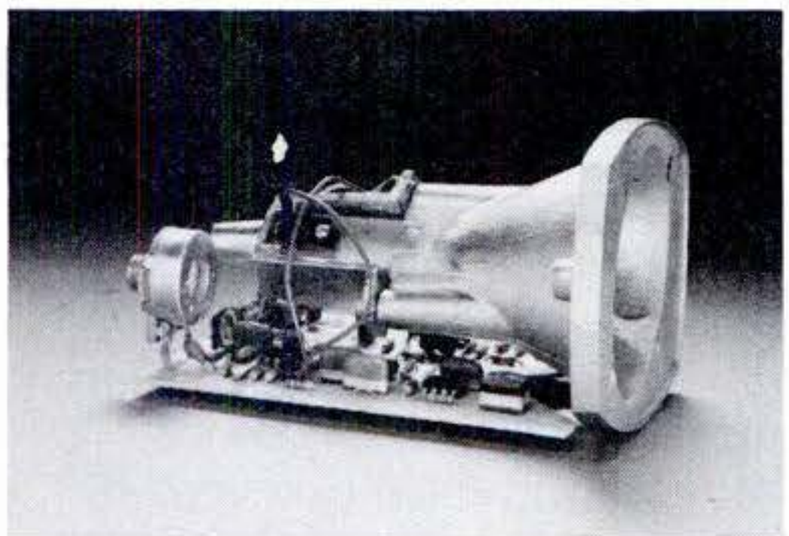
POLICE RADAR MEETS ITS MATCH.

You can't buy a better radar detector for $95 than the GUL Micro Scan. Developed by B.E.L. Laboratories after 10 years of research, the GUL Micro Scan has repeatedly proven its superior signal sensitivity. In separate tests conducted by Canadian Tire Corporation and *Motor Consumer Report,* it demonstrated a detection distance significantly greater (on both X and K bands) than its top three competitors—the Fuzzbuster XK, the Whistler XK and the XK Snooper.

That was only the beginning.

Plenty of advance warning.

In two recent issues (January and February, 1980) *CB Magazine* revealed an unprecedented comparison showdown involving 12 leading detectors—



Large elliptical horn antenna detects radar from all sides, even when approaching hills and curves.

some with prices as high as $200.

Monitoring straight line detection, the GUL's 9,029 foot range topped the list.

Signals of .01 millionths of a volt are sufficient to trigger the GUL's scanning alert system (ranging from 9.445 to 24.445 GHz). It successfully detects all police radar—including the new KR-11 short pulse.

What's more, the GUL has a nondirectional antenna; its large elliptical horn pulls in signals from front, side and rear. This 360° detection field maximizes sensitivity, providing you with valuable warnings—even when approaching hills and curves. *CB Magazine's* comparison bears this out: In a K band test for around-the-curve sensitivity, the GUL's detection range was double that of the Fuzzbuster and Super Snooper. And nearly three times greater than the highly regarded Whistler. On X band pickup from the side and from behind, it was found to be the most effective detector in the dozen.

Doesn't cry "wolf."

The most common problem among radar detectors is the failure to screen out false signals, such as signals from taxis and ham radios, as well as hospital microwaves.

But the GUL shows no sign of falsing when exposed to radio signals of any kind. Its sophisticated circuitry is completely shielded by a diecast and extruded aluminum case which protects the input terminals from stray signals (the most common cause of false alarms). The aluminum provides lightness, along with durability not found in plastic casings.

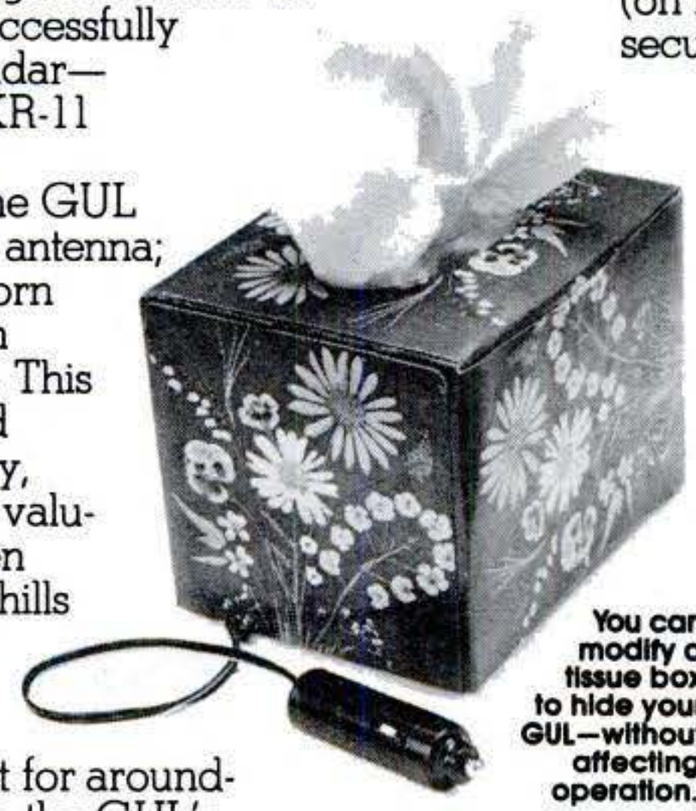
A double warning system.

Both a tone and light come on in the presence of radar, and remain on until radar is gone. You're never lulled into a false sense of security by a tone that sounds once and then goes off. You control the tone with a front-mounted on/off switch.

In addition, the GUL uses an internal voltage regulator, commutating filter, and synchronous detector to reduce power consumption to a minimum. This also provides a more stable gain setting. And its gain control knob lets you optimize sensitivity for different city and country conditions.

Quick installation.

The compact GUL measures only 4″ × 3″ × 4½″. It weighs just 20 oz. Its case is finished in glare-free matte black, and comes with bracket in place. To mount, simply fasten the adhesive Velcro pad to the top of your dashboard; a matching Velcro foot (on bracket) keeps the unit securely anchored. This Velcro mounting allows for easy removal in seconds to prevent theft (the unit is even small enough to be stowed in any glove compartment). To supply power, simply plug it into your cigarette lighter.



You can modify a tissue box to hide your GUL—without affecting operation.

Try it yourself.

Order the GUL Micro Scan today. Road test it for yourself. If you don't find it to be the finest electronic counter-intelligence you can own, return it within two weeks for a courteous refund. The Sharper Image guarantees your satisfaction. Comes with complete instructions and 120 day warranty.

ORDER NOW TOLL-FREE.

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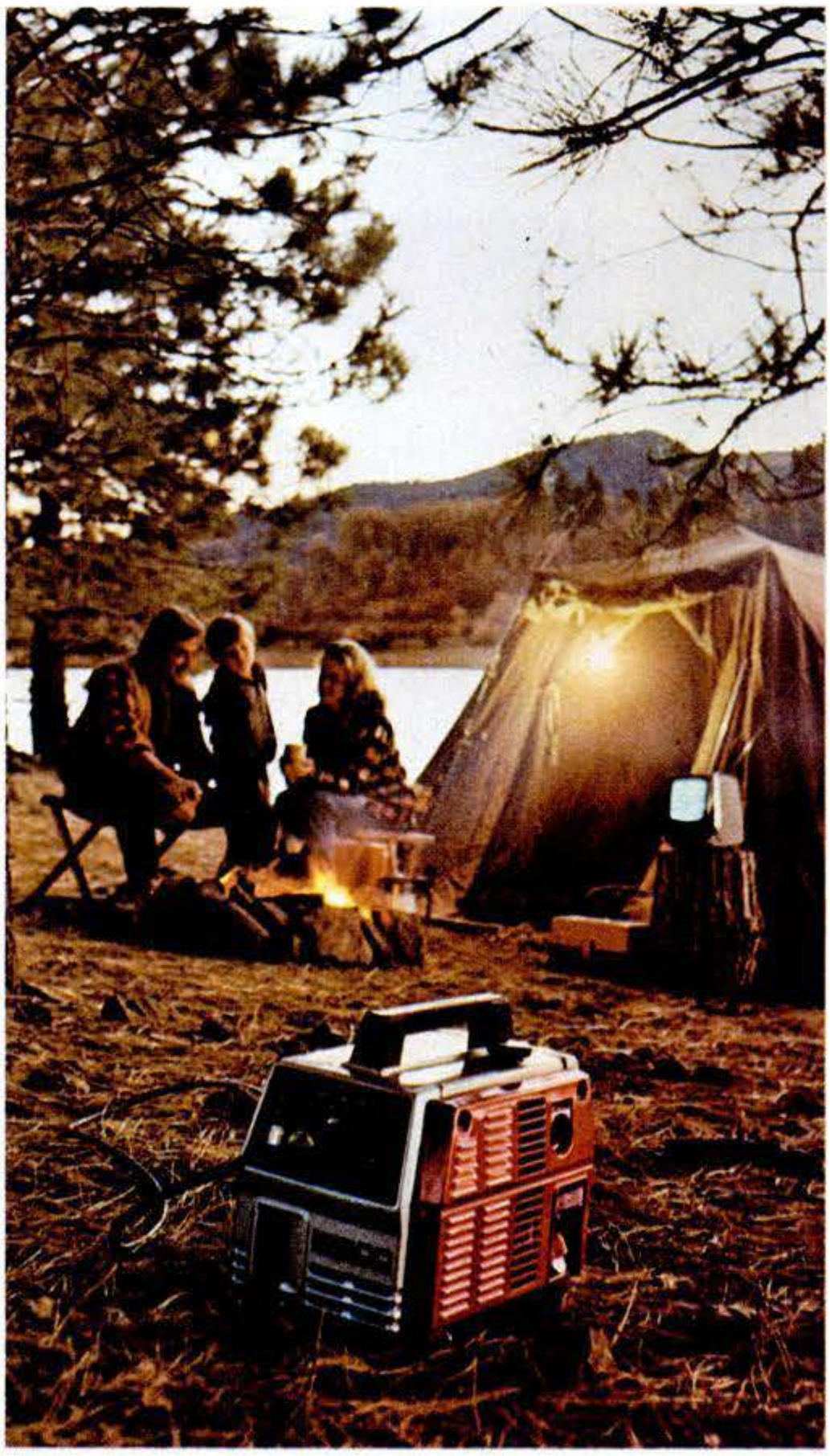
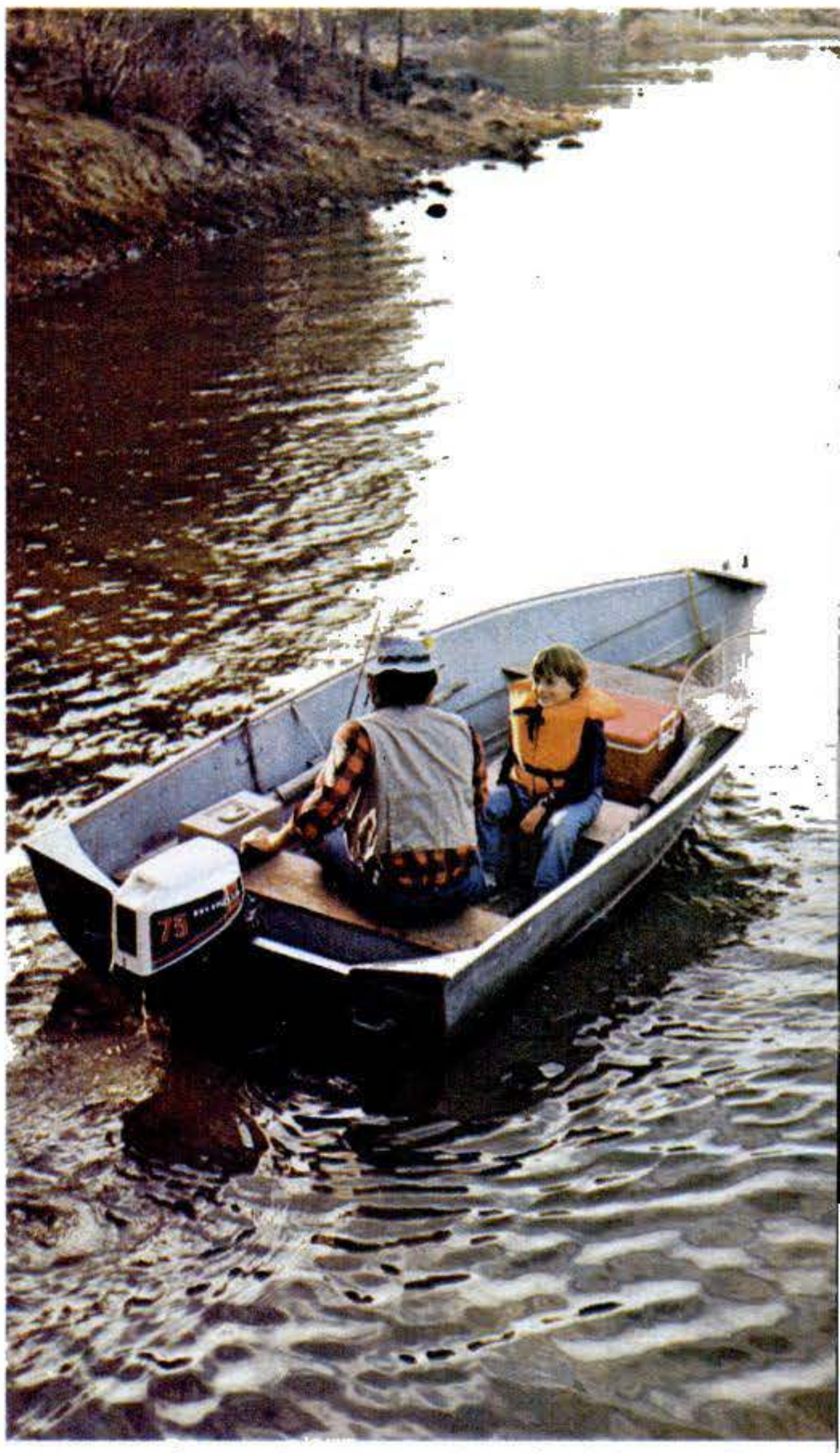
POWER TO CAMP OUT OR SHIP OUT.





When you're in the great outdoors, you never want to get in a position you're powerless to control. And that's where Honda comes in.

PORTABLE POWER.

The new EM-500 portable generator is the ideal companion for campers and hunters. It gives you a maximum 500 watts of power in a lightweight 40 lb. package about the size of a portable TV.

Whether you need to power your camping accessories, charge your RV battery or just warm-up under an electric blanket, the EM-500 does it quietly and economically—about 4 hours on a tankful of gas.

It's great for small power tools, barbecue motors and electric fans, too. And it can really light-up a camp site.

In addition to the EM-500, Honda has a full line of portable generators from 400 to 4,500 watts.

NAUTICAL POWER.

Honda has power for boaters and fishermen, too. A line of 4-stroke outboard engines that come in 7.5 and 9.9-hp models, both with short or long shaft.

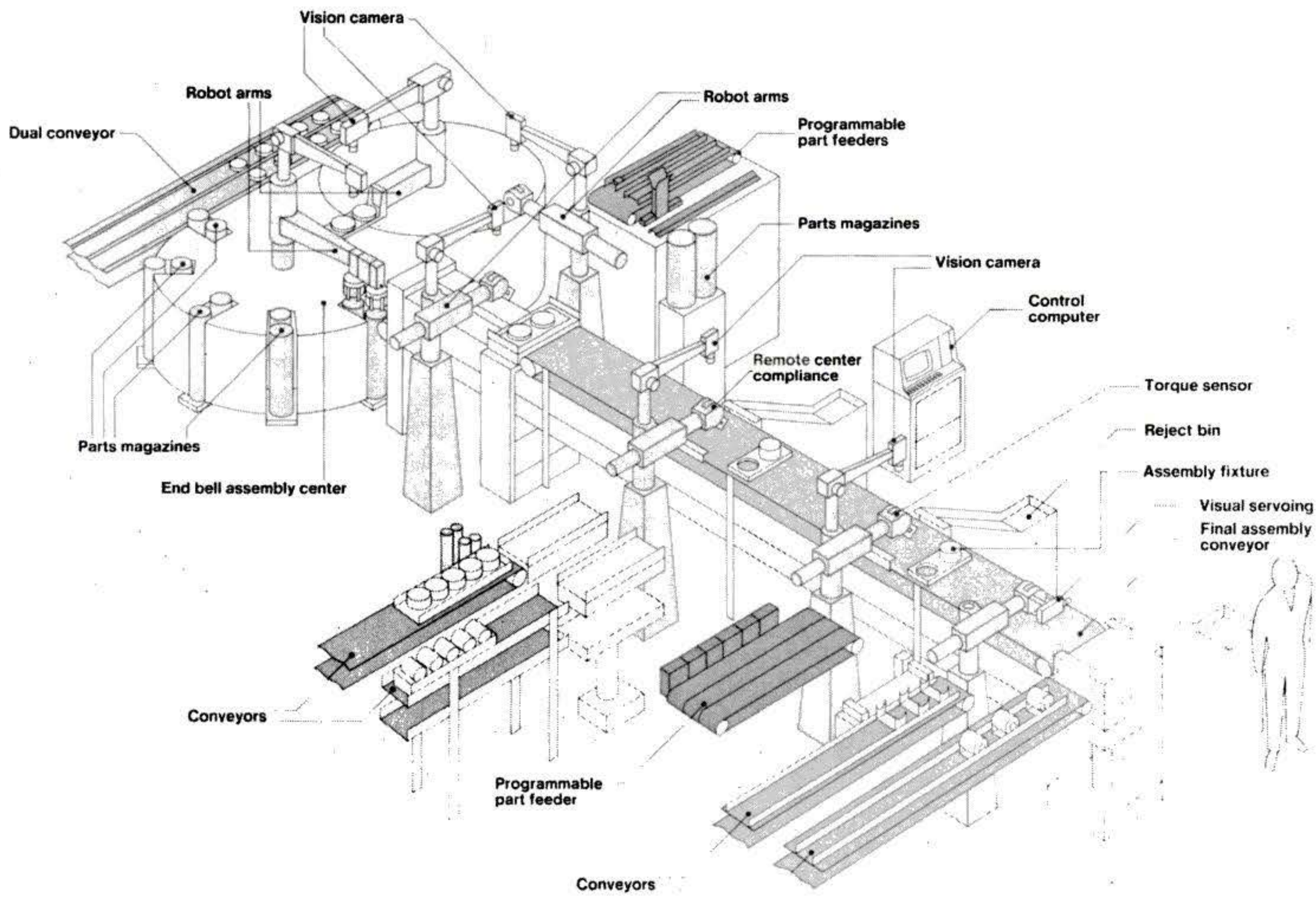
Honda's 4-stroke design means quiet operation. Quick response and powerful acceleration. Maximum fuel economy—over three hours on a tankful of fuel under full throttle. Smoother operation. And less pollution because there's less oil and smoke discharge.

These engines are ideal for trolling. They have the power to keep from drifting at low RPM's without fouling the plugs.

Before you head out on your next trip, let your nearby Honda dealer tell you about Honda power. Just look in the Yellow Pages or call toll-free 800-648-5311 (Operator 99).

IT'S A HONDA

©1980 American Honda Motor Co., Inc. For optimum performance and safety we recommend that you read the owner's manual before operating the unit.



Futuristic assembly line, designed by Westinghouse, uses robots that can be quickly reprogrammed to adapt to changing requirements of batch manufacturing.

to handle everything a good robot arm should do, Unimation's Carlisle said.

"The software is extremely complex," Carlisle explained. "Each joint goes through a coordinate transformation ending up with six four-by-four matrices to be solved. The LSI-11 outputs a new point every 29 microseconds, and at the same time, internal microprocessors are doing 32 recomputes on the motion."

Such high-speed computer control means that the robot's electric control motors receive new movement instructions faster than they can turn off and on again. The result is a superbly efficient robot that can move its arm with pinpoint accuracy to almost anywhere within a three-foot sphere. Motion is absolutely smooth and can be extremely fast—up to 10 feet a second at the tip of the hand.

And this advanced robot doesn't have to be shown how to do each new task—it can now be told.

PUMA's developers came up with a special computer language called "Val." It includes about 100 English commands that make it easy to teach a PUMA new tricks. The commands include "here," "approach," "move," "depart," and other words.

"It lets us define points along the path we want PUMA to move," Carlisle said. "Point 'B,' for example, can be at the center of the hand, or define a special tool, or be at the end of the tool. PUMA will remember where 'B' is."

The number of points PUMA can learn is limited only by computer memory. "It could have hundreds and hundreds of points," Carlisle said. "We taught one to draw a picture of itself. It had to learn 150 points.

"We're building robots that are so accurate that we know more about where the tip of the hand is than we do about where the tool or component is," Carlisle said with some pride.

Now Carlisle and the Unimation research team are concentrating on developing sensors to make PUMA even more versatile. Sensors fitted into robot hands, for instance, can let PUMA pick up an egg or a brick with just the right force.

Carlisle is excited by the future. "We've built the tool," he said. "Now we'll see what we can do with it."

At the main production plant in Danbury the robots are assembled and tested under strictly controlled conditions. Inside the main door one day last winter, two PUMA's stood corralled behind a yellow fence. The noise was like that from caged animals, a low, throaty growl of gears and rumbling whine of small motors. The PUMA's stood there waving their arms up, down, sideways, and around—again and again going through the motions.

Each robot goes through a precise calibration exercise that ends with installation of a customized memory chip that knows exactly how this robot moves. If a control motor is changed during later maintenance, a new calibration is needed.

Once calibrated, each PUMA spends 80 to 100 hours in a cage waving its arm through precise motions—a test that guarantees accuracy.

But once in a while, something goes wrong. A single PUMA stood in another cage, technicians working on its interior. And on its arm were painted two human figures.

"We don't know what's wrong with him yet, but he whacked a couple of guys who got too close," a worker said. "We call him 'killer.'" PS

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DETROIT REPORT

By JIM DUNNE

Automatic-overdrive fix

Ford plans to fix the stalling problem in its Automatic Overdrive Transmission that PS discovered during our recent test of a 1980 LTD [PS, April]. "We still consider it a driver irritant, not a safety problem," reported a Ford spokesman. "We have a number of solutions that involve a new design, and when we decide which one is best, it'll go into the car right away," he added. Ford claims it has 100,000 Automatic Overdrives in service and no record of consumer complaints. In all, the company points out, it conducted 1.3 million miles of its own testing plus 750,000 miles of fleet use by commercial and police vehicles, with no report of engine stalling. Right now Ford has no date for getting the fix into production, but may make the correction before the 1981's begin coming off assembly lines. It is interesting to note that while Ford claims it didn't experience problems in extensive testing, the company confirms that stalling did occur on three vehicles checked by journalists, including two tested by PS. This stalling occurs when brakes are applied very quickly and firmly while the transmission is in fourth gear (lockup mode). The major problems resulting are loss of power-steering assist and, if the brakes are pumped, loss of their power assist, too.

Stamped-steel engines?

The cast iron used in engine blocks and cylinder heads is a major target of engine designers who want to cut weight to increase fuel economy. Plastic has been talked about for piston cores and valve covers to replace iron, aluminum, and steel. Now, though, designers are looking at stamped steel to replace cast-iron engine blocks. With stampings, the weight can be cut to that of aluminum, but with lower costs for material and fabrication. U.S. Steel has a Vega-type engine with a stamped block undergoing testing now. The head is still an iron casting, however, for rigidity.

Cadillac valve selectors

Valve selectors are being readied for 1981 Cadillac engines. These devices, designed by Eaton Corp., selectively shut off two cylinders in Cadillac V8's to allow the cars to run on six cylinders when cruising or idling. The result: a gas saving of 40 percent at idle, 25 percent at low-speed cruise, and 15 percent at highway cruise. While the cylinder shutdowns are a major fuel saver, savings also come from throttling-loss reductions and from operating the engine at a higher load, thus burning more of the gasoline *in* the combustion chamber, not part way down the exhaust system. Actual fuel-economy improvement could be as much as two mpg.

Aluminum radiators coming

Big Chevrolets and Pontiacs are getting the lighter-weight aluminum cooling units in a pilot project that may lead to universal use throughout GM's big-car lines. They'll replace heavier copper radiators on 15,000 1980 models as part of an experiment to prove the lighter metal. Aluminum radiators are 10 pounds lighter than copper ones. Among American-built cars, only Corvettes and Volkswagens currently use aluminum radiators.

Commuter cars shaping up

Looking beyond the trend to smaller, front-wheel-drive compacts, the birth of the two-passenger commuter car can clearly be seen. That's the direction in which planners are aiming for the cars of the late 1980's and 1990's. These commuter cars will serve as basic runabouts, and could average above 40 mpg in *city* driving, thus beating the squeeze of rising fuel costs. Engines would still be gasoline- or diesel-fueled, according to present plans, with electric power a possibility. Among engine proposals are two-cylinder designs of less than 50-cu.-in. displacement. Bodies would be big enough to seat only two, in bucket seats, with a large cargo area accessible through a hatch.

Pontiac's two-seater

After at least two unsuccessful attempts to get an okay from GM management for a two-seater sports car, Pontiac appears to have the go-ahead. The division plans to build a small sportster similar to the VW Scirocco, using the X-car drive train. Instead of front-wheel drive, though, the power train will be turned around and mounted in the rear to create a midship engine layout. Pontiac's proposal will have the 2.5-liter four and 2.8-liter V6 as the power plants in a car that will sell against the RX-7 and TR-7, at a couple of thousand dollars below the Corvette. Advantages of the plan include a ready-made drive train and even better fuel economy than the Citation's 24-city/38-highway EPA ratings. At the same time, performance would match that of the quicker V8's, due to the lighter weight of the car's proposed plastic body. Over the past 15 years, Pontiac's two-seat sports-car plans have been killed by GM management because they matched the Corvette's specifications too closely. This new car would be unique to GM's lineup and pose no competition to the Corvette.

Ford's four-cylinder plans

The new engines for Escort/Lynx could soon be Ford's biggest-selling power plants, if current plans work out. Ford will build 638,000 of the 1.3- and 1.6-liter fours in the first phase of its new engine-line schedule, now starting in Dearborn. Within one year, a second phase will begin, boosting production to 1.1 million per year. Only 10 years ago, the V8 engine dominated Ford's production, and was installed in 84 percent of the firm's cars. In 1978, the percentage was 63; this year, it plummeted to 39.

Import quality better

In a survey conducted by the authoritative *Ward's Auto World,* an industry publication, "several hundred" auto-industry engineers feel that imports offer the best quality. Japanese products were thought to offer the top quality by about 48 percent of the respondents. Only 27 percent said U.S. cars were best. German products got 23 percent of the votes, while auto makers from France, England, and Italy each received 0.4 percent shares of the vote. The results constitute an unusual endorsement of Japanese products by competitive companies, but were accompanied by statements that U.S. products will get better in the future—mainly through automation.

Lowdown on gasohol

It is now officially recognized that you can safely use gasohol's blend of 10 percent ethanol and 90 percent gasoline without damaging your car's fuel system or engine. The auto companies have indicated that they will stand by their warranties if the mixture is held to that proportion.

Who buys sports cars?

A recent Mazda study of RX-7 owners revealed that a large percentage earn high incomes and are well educated. About 89 percent have had some college training, 39 percent holding a degree. Average income was reported at more than $29,000; 16 percent earned over $50,000 per year. Males dominated the buyers, at 91 percent, and median age was 31. Mazda is anxious to sell to more women.

Most popular options

A Chrysler study shows that 87 percent of new cars purchased are sold with air conditioning and automatic transmissions. Radios are ordered by 83 percent of all buyers, and about 30 percent of them buy stereos. A study of 1978-model sales by the Motor Vehicle Manufacturers Assn. lists these percentages for familiar options: power steering, 92 percent; tinted glass, 84 percent; rear-window defogger, 39 percent; speed control, 35 percent; power windows, 28 percent; power door locks, 24 percent; sunroof, 3.8 percent. PS

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People write to PENNZOIL

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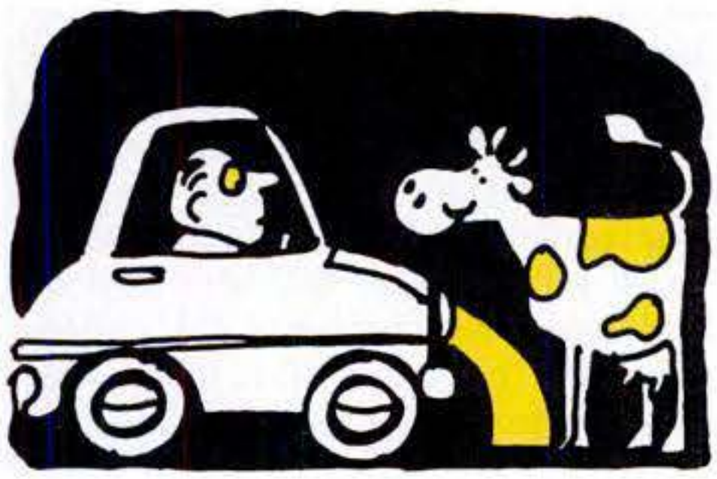
Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Diesel Update. What diesel oil ratings today correspond with the old "DM" and "DS" ratings? Are both of these diesel oils designed for different uses?

D.M., Elm Grove, WV

The API service ratings DM and DS have been replaced with the letters CC and CD respectively. The CC quality oil is designed for lightly super charged diesel engines and heavy duty gasoline engines. CD oils are designed for super charged diesel engines and they're formulated to protect the engine from high temperature deposits where a wide variety of fuels are used.



Dim And Flare It. For the past year or so, when I rev up my car's engine, the headlights flare up, and when the engine returns to idling they dim back to normal. A few weeks ago I replaced my battery and alternator, thinking that these changes would remedy my headlight problem. However, the condition still exists and I'm still searching for a solution. What's your advice?

H.M., St. Louis, MO

The fact that your lights flare up and dim with variations of engine speed seems to point to a bad ground connection in your headlight system. You should also make sure that your engine is properly grounded to the car's body frame. One more area to check is your voltage regulator, which could also be the source of your problem.

To Tell The Truth. What is the difference, if any, between your 2-stroke motorcycle oil and your 50 to 1 oil in the plastic bottle?

F.H.C., Prescott, AZ

Pennzoil 2-Stroke Motorcycle Oil in the 1 quart can is recommended for pre-mix applications in motorcycle engines. Pennzoil Multi-Use, 2-Cycle 50 to 1 Oil in the plastic bottle is recommended for all types of injector systems including motorcycles, as well as pre-mix systems other than motorcycles. The two products are basically similar, except that the Multi-Use, 50 to 1 Oil is prediluted with a portion of solvent to provide better flow characteristics and mixing with fuel in certain applications.

When In Need. I use Pennzoil 20W-50 oil in my 1977 Yamaha. Would there be any problem in adding Pennzoil 10W-40 oil to the crankcase if I am on the road and can't purchase the 20W-50 motorcycle oil?

L.P., Sterling, Kansas

Automotive and motorcycle oil meet the same American Petroleum Institute service classifications. If 4-stroke oil is not readily available when you are on the road, you may use Pennzoil Z-7 SAE 10W-40 when temperatures are below 20°F., or Pennzoil Z-7 SAE 20W-40 or 20W-50 when temperatures are consistently above 20°F.

Beat The Heat. I'm interested in protecting my automobile engines in extreme heat. I have 2 cars with air-cooled engines, a '65 VW and a '69 Porsche, and 1 water-cooled vehicle, a '77 Volvo. I think that an SAE 40 will be the best oil during real hot weather for my air-cooled engines, but was thinking of using a multi-viscosity oil in the water-cooled engine. What are your thoughts on this?

A.S., Shingle Springs, CA

For your two air-cooled engines, we'd agree with your choice of SAE 40 for temperatures above 77°F. For water-cooled engines such as your Volvo, multi-viscosity oils function better since there is a longer time involved for engine warm-up. The oil must flow freely at start-up and during the period until the engine reaches operating temperatures.

As Time Goes By. Following an oil and filter change, my car with 130,000 miles on the engine requires the addition of oil as follows: one quart after 1,000 miles, second quart after 800 miles, and third and subsequent quarts after 500 mile intervals until the next oil change. Can I assume from this pattern that the oil is being used faster as it gets older?

W.C., Flushing, NY

Oil consumption in older automobiles is not unusual. In most instances, it is not considered a critical problem unless you are using one quart every 400 miles. There are a number of causes of excessive oil usage. One of the functions of a motor oil is to seal combustion chamber pressures. If an engine is overfueling, some of the gasoline will enter the crankcase and mix with the oil. This has a thinning effect on the lubricant and it can no longer properly seal the combustion chamber. Therefore, the longer you use the oil the greater the increase will be in oil consumption. Other causes for oil consumption include external leakage, high speed driving, engine wear and too light of an oil.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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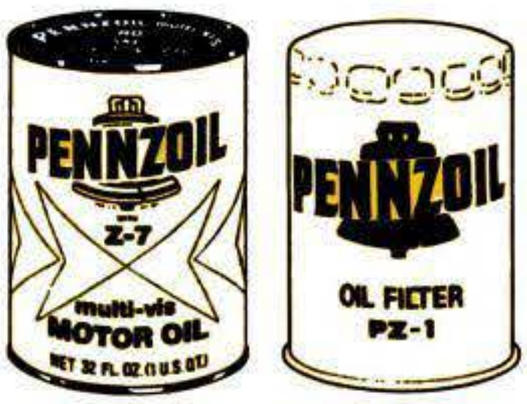

ask for it!

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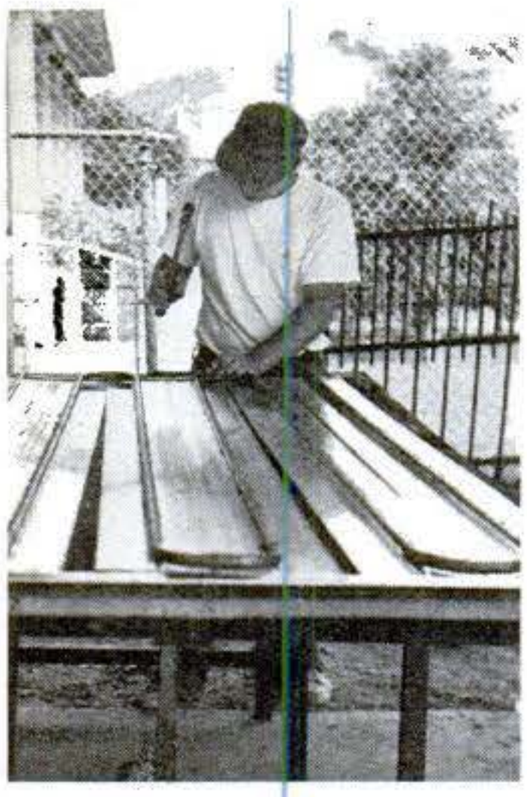
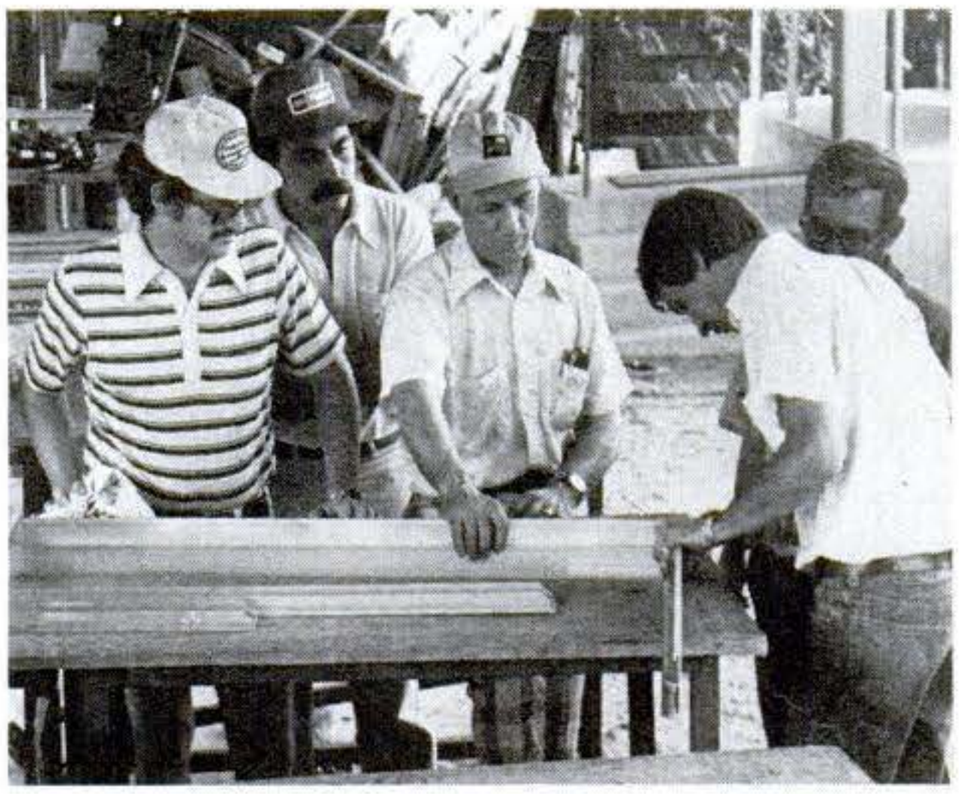
A bimonthly sampling of projects PS readers have devised to conserve or replace fossil fuels

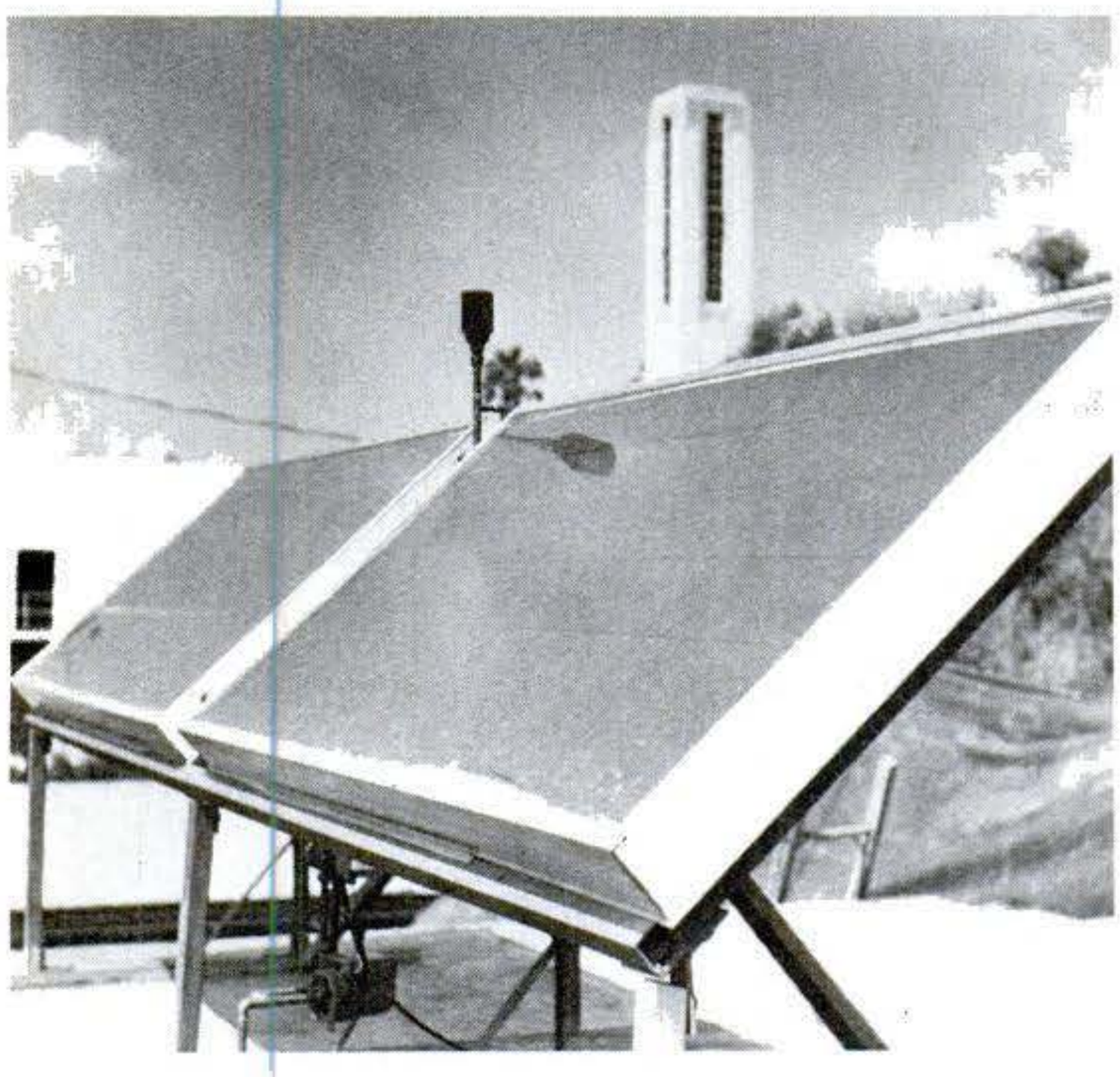
Solar for credit

Take a two-day workshop and build your own low-cost system

By ERNEST SNYDER

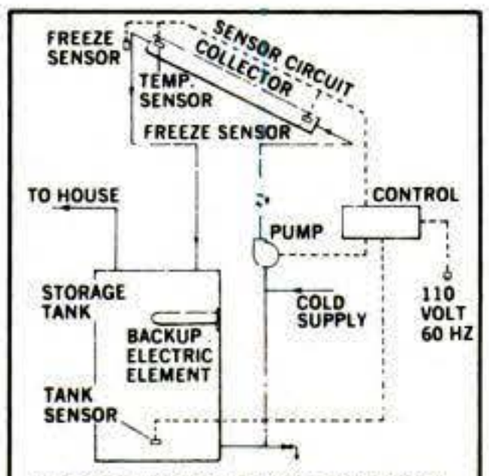




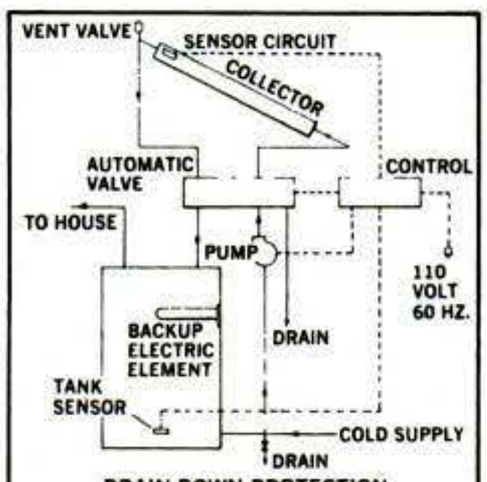


Gathering around the solar collector, workshop participants learn hands-on assembly of components (photos above). Typical two-collector system, installed on the roof of a graduate's home, is shown at left.

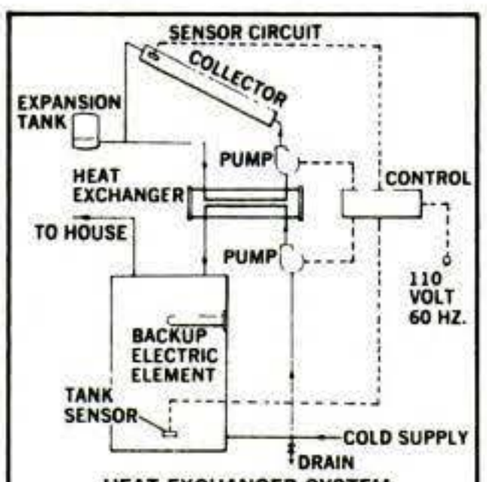
Three ways to protect against freezing are shown below. Circulation protection (left) is used where freezing is infrequent. Drain down (center) and heat exchanger (right) are used where freezing is likely.



RECIRCULATION FREEZE PROTECTION



DRAIN-DOWN PROTECTION



HEAT EXCHANGER SYSTEM

Hundreds of people in the Southwest have built professional-grade solar water heaters costing from $165 to $420, after tax credits. The materials—preformed and ready for assembly—are supplied by Suncor, Inc. (930 W. 23 St., Tempe, Ariz. 85282), and the know-how is offered by a number of universities and community colleges.

The concept for this project originated at the College of Architecture at Arizona State University. It began as a graduate seminar in alternate energy and has snowballed to the point that weekly workshops are conducted at the university. Workshops also are conducted by community and junior colleges in Arizona and Southern California.

Registration for the course normally involves paying a nominal tuition fee; payment for the materials is made directly to the supplier. Most schools run the workshops on a Friday evening and all day Saturday. Others operate three or four successive evenings. The final product for each participant: two complete solar collectors (35 square feet); one pump and motor; freeze-protection hardware; thermostatic controller; plus miscellaneous valves, sensors, and fittings. Roof or other mounting supports for collectors, and the pipe and insulation needed to connect collectors to the hot-water storage tank, aren't included.

The lecture session consists of three hours of information, including a brief introduction to solar water heating; system specifications; instructions for retrofitting an existing hot-water tank; how to install collectors, pump, freeze protection, and controller; how to start and drain the system; and how to obtain a building permit.

Solar assembly line

The instructor gathers the class around one of the work tables and shows the group how to join the ½-in.-dia., prebent, serpentine copper pipe to the extruded-aluminum collector plates. As the assemblies are completed, they are cleaned and stacked, and high-temperature, flat-black paint is applied to the absorber plates.

As the day progresses, the group assembles other subunits: extruded-aluminum sides and ends and flat, sheet-aluminum backs for the collector boxes; the ⅛-in.-thick tempered-glass cover in its extruded-aluminum frame; and the ball valve, motor, pump, check-valve group, and miscellaneous hardware.

The final step is to assemble the subunits to form completed collectors.

Continued

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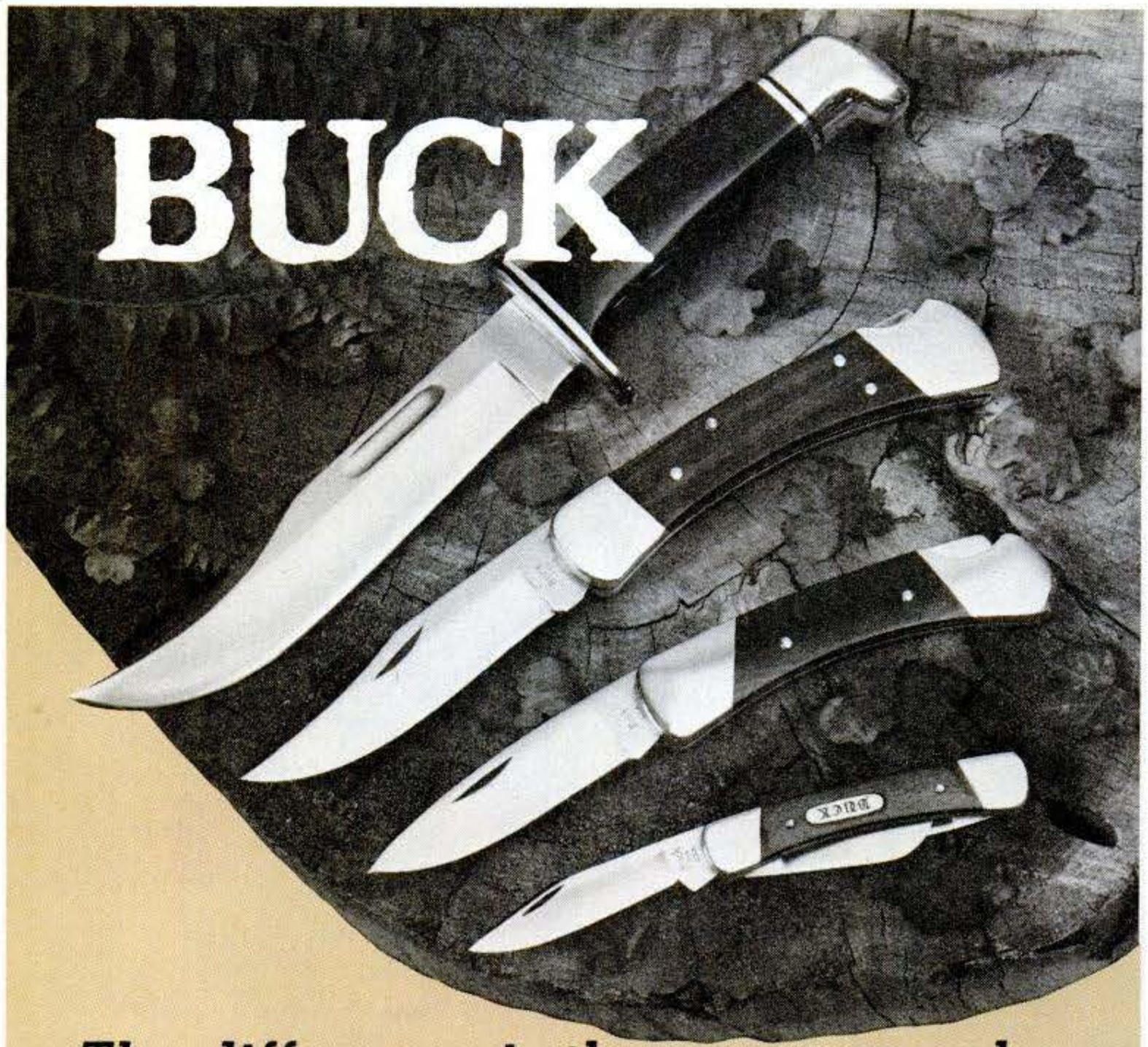

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Solar for credit

[Continued]

Fiberglass insulation, 2½ in. thick, is placed in the box, the absorber assembly is installed, and the glass cover is set into place. By five o'clock on Saturday, the workshop participant loads two complete collectors and other materials into his car and heads home to spend the next weekend installing his solar hot-water system.

Fear of freezing

Freeze-control methods vary with climate. In the Sunbelt, where freezing conditions are infrequent, a recirculation system is used. Warm water from the hot-water tank automatically circulates through the collector when the collector temperature sensor reaches 4 deg. C (38 deg. F). For colder climates where freezing conditions are common, a drain-down system is frequently used. When freezing threatens, the water automatically drains from the collector coils (about one gallon). The system automatically refills when the temperature rises. A double-loop heat-exchanger system using a fluid containing antifreeze in one loop and potable water in the other also may be employed for freeze protection.

One question that's frequently asked is, "Can I buy a kit of materials and do the job on my own?" The answer: no. The main reason is that there are many places in the assembly of components where builders might make mistakes that would result in unsatisfactory system performance. Suncor does sell assembled units ready for installation, but the price is considerably higher than those quoted earlier.

As for how to cut the cost even further with tax credits, see "How to Cash In Now on Federal Energy Credits," PS, Nov. '79. After credits, payback for the system is usually less than two years, frequently less than one.

FOR MORE INFORMATION

Author Snyder is the proud owner of a solar water-heating system that cost him only about $185 (after tax credits). He'll answer readers' specific questions if accompanied by a stamped, self-addressed envelope. His address: 208 E. 14th St., Tempe, Ariz. 85281.

Your idea may bring you $200

Every other month, we present a project developed by a PS reader and pay the inventor $200. To enter, send us black-and-white glossies (one photo should show you demonstrating the device), plus a description and sketches. Include your name, address, and social-security number. No material can be returned unless you enclose a stamped, self-addressed envelope.

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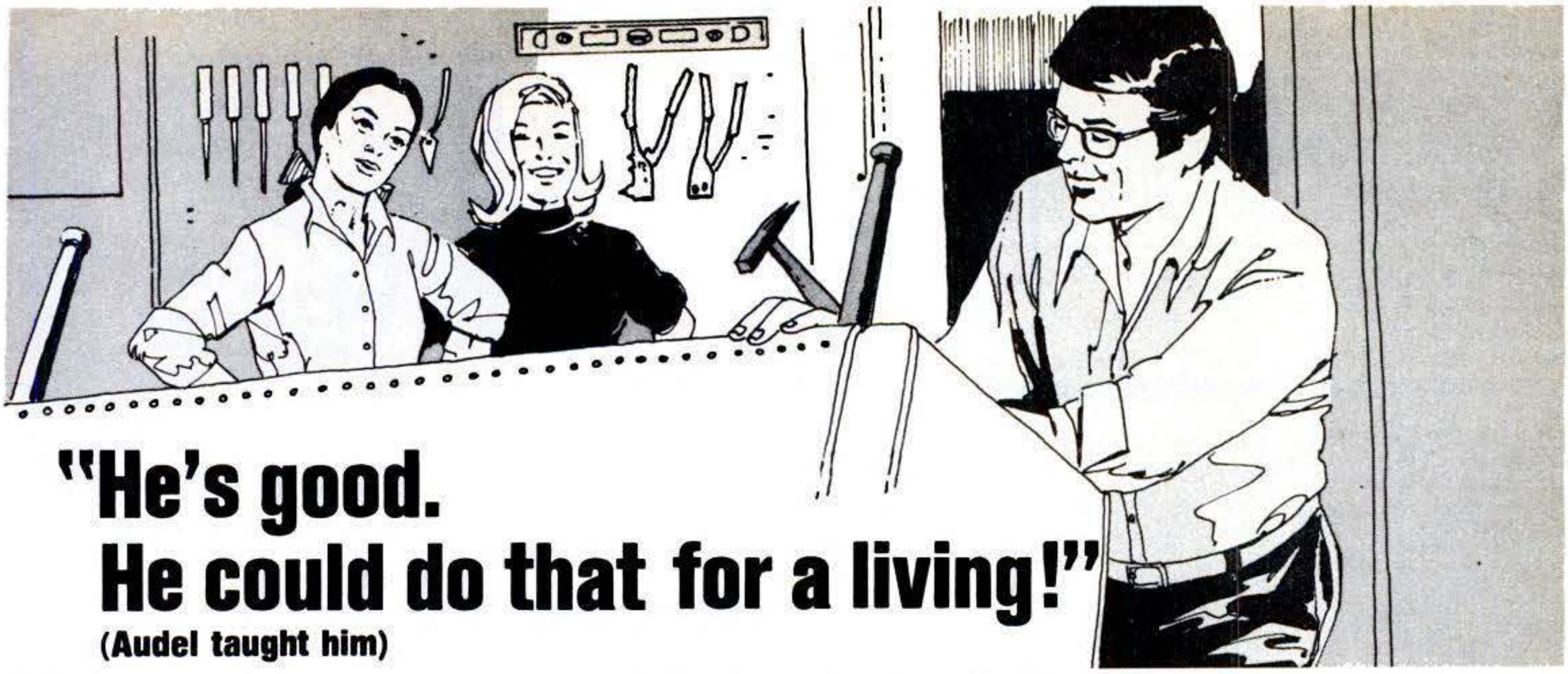

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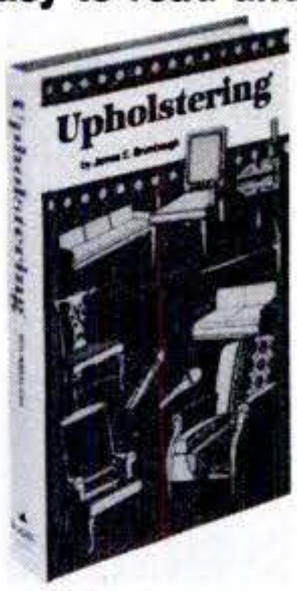

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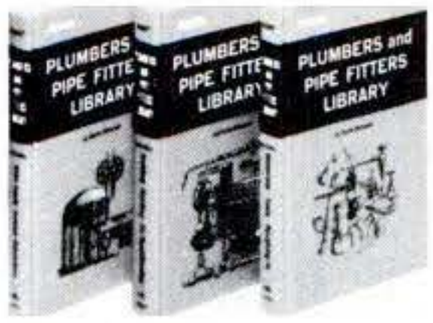

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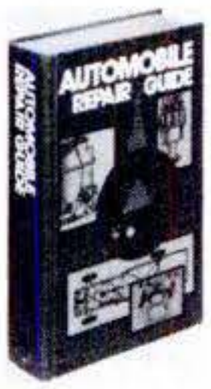

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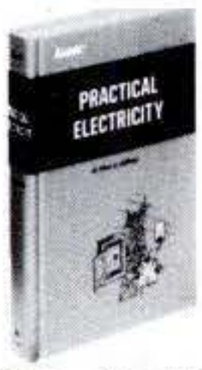

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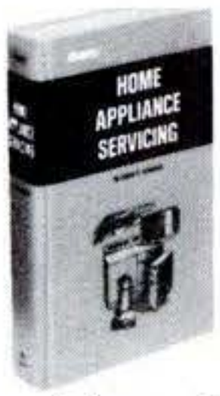

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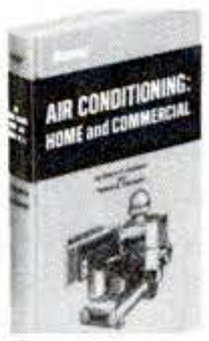

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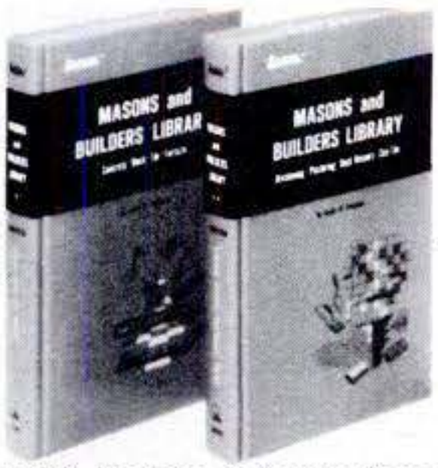

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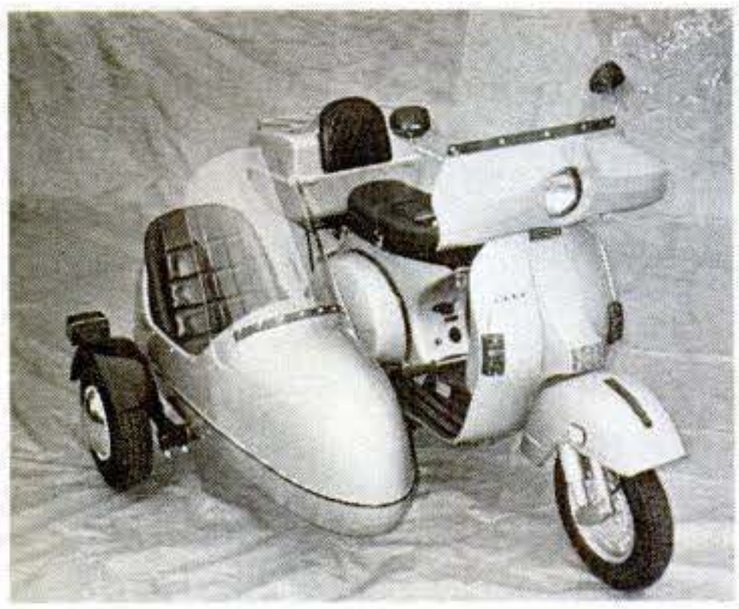
MOTORCYCLING

By RAY HILL



Vespa sidecar

You can add a little flash to your Vespa motor scooter with this new sidecar from the California Side Car Co. Inc. (1630 Oregon Ave., Long Beach, Calif. 90813). It fits any Vespa scooter made since 1949. Although compact, it has ample room for an adult, according to the maker. It's made of fiberglass and has a carpeted interior, hinged seat, taillight, windshield, and deluxe body molding trim. All this can be yours for $799, plus shipping.

Ever wonder, by the way, what kind of mileage a Vespa motor scooter gets? Or how it behaves as an all-weather commuter? In an upcoming issue we'll be taking a look at the Vespa scooter and supplying answers to these questions.

Safety tips

The U.S. Department of Transportation has published a new booklet called "Ridin' Along Side by Side." It offers "tips that will help make roads safer for drivers of vehicles of all shapes, sizes, and performance capabilities." Here are some of the tips.

The automobile driver should:

Allow room for cyclists' unexpected shifts in lane position or sudden braking and acceleration.

Use caution when changing lanes or when entering a major thoroughfare from a side street, driveway, or parking lot.

Be prepared for unusual maneuvers by motorcyclists.

Consciously look for motorcycles at intersections.

The motorcyclist should:

Anticipate errors by other motorists.

Reduce speed before making a turn.

Ride with the headlight on at all times, wear bright-colored clothing, and use reflecting tape on helmets and motorcycles for increased visibility.

Slow down before crossing railroad tracks and maneuvering around potholes.

Attempt to make eye contact with automobile drivers at intersections.

A free copy of the pamphlet is available from "Ridin' Along Side by Side," National Highway Traffic Safety Administration, NAD-42, Washington, D.C. 20590.

Removing a handgrip

There are various ways of removing a stubborn handgrip from a handlebar. One quick way that people sometimes resort to after vain attempts at pulling the thing off is to cut it off with a razor blade. Very effective. And quick. But now you have to replace it with a new one.

Here's a method that I've found works well: Insert a long thin screwdriver between the handgrip and the handlebar and pry the grip away from the bar some. Spray some carburetor cleaner between the handgrip and the handlebar. Repeat this process at three or four places around the handgrip. Rotate the grip, and slide it off.

Helmet lock

Here's a new helmet lock for full-face helmets. It's much more reliable than factory-installed neckstrap locks, claims the maker. It mounts to any tubular frame member and folds out of the way when not in

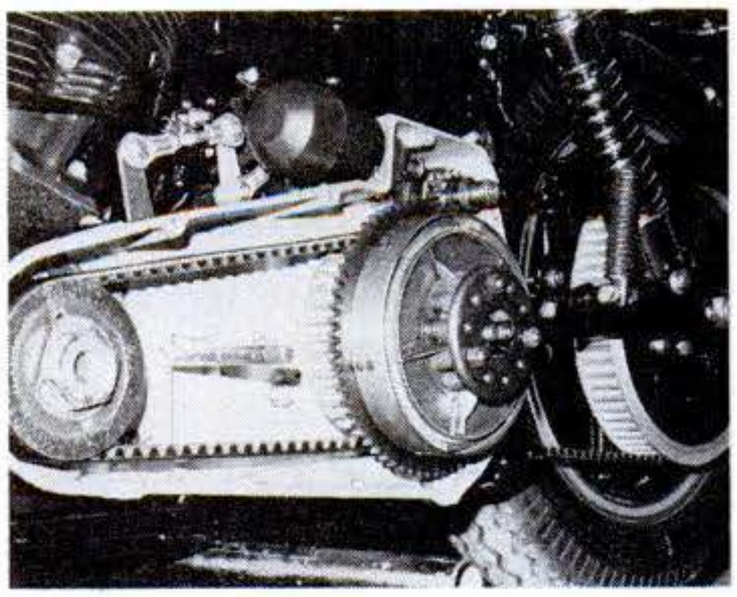
use. Its new design encircles the full-face face guard of one or two helmets in its locking jaws. HelmetLock comes in a flat-black finish and is $19.95, including shipping, from CycleTogs International, Box 19414, Multnomah Station, Portland, Ore. 97219.

No-fling chain lube

Getting tired of wiping chain lube off your rear wheel? The folks at Watch Chemical Labs in Cincinnati have heard your cries. They claim to have solved the problem with "10:1." The maker says it's a 20 percent synthetic that sprays like a penetrating oil and then sets up a tough lubricating film. It won't wash or wipe off a chain under water, mud, and dirt conditions, and won't fling off at any chain speed, the maker claims. I haven't tried it. But if oil flinging off the chain onto your rear wheel is a problem, you might want to try a can. It's available at dealers.

Harley tries belt-drive

Harley-Davidson is producing 1200 limited-edition motorcycles this year. The machine is called the Sturgis—named after the famous Black Hills, S. D., motorcycle rally. The Sturgis is based on Harley's 80-cubic-inch Low Rider model. The unique thing about it, though, is not its name or



styling. It's the drive line. A Gates polychain belt will handle the primary drive as well as the final drive. The primary belt is 13.8 mm wide, and the final drive belt is 14 mm wide.

Harley says this system is lighter, simpler, smoother, and more efficient than a shaft drive. And it's quieter and smoother shifting than a chain. It requires no lubrication and minimum adjustment. Harley engineers expect the belts to last for 20,000 miles.

Another neat item from Harley this year is found on the FLT 1340. It has a totally enclosed rear chain running in a light oil bath. This, engineers say, enables chain maintenance to be extended to 5000-mile intervals.

Electronic fuel-injection

Soon we'll be taking an in-depth look at Kawasaki's new electronic fuel-injection system. It's supposed to eliminate cold-start drivability problems. PS

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REMINDER: BE GOOD TO YOUR LAND

Rugged as the new Datsun 4x4s are, it's important to respect the natural beauty of our wilderness land. Use 'em on the off-road roads, and in designated rec vehicle areas. That'll keep us all truckin' for a long time to come.

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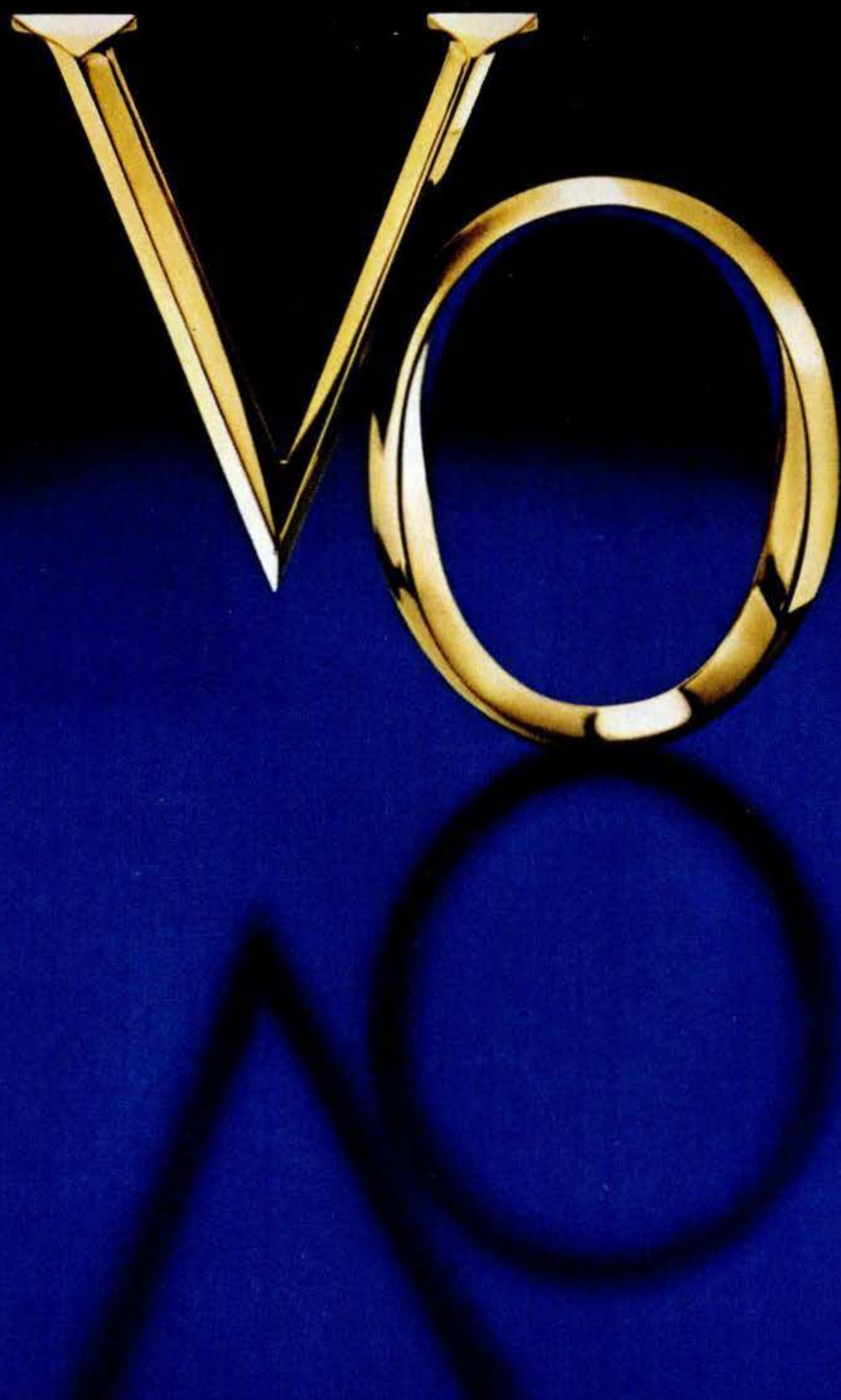

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Popular Science

PS | What's News

Article ideas often take time to develop and mature. This month's cover story is a good example. We first heard of the Solchem process back in October 1976. Talbot Chubb supplied us with some information on the development that he and his colleagues at the Naval Research Laboratory had been working on. We were fascinated by the ingenious idea: basically, that solar energy could be converted at the receiver into chemical energy, which would be easier to transport, store, and handle than heat energy.

At the time, we were tempted to move ahead with a story describing the process. But Solchem was in the paper-study phase then; that is, no hardware had been built. It existed only as a series of calculations that showed that it should work.

As you can imagine, we see a lot of things in the paper-study stage, particularly devices, systems, and ideas related to energy production, conversion, and conservation. Some of them will ultimately turn out to be important. Others may contain hidden flaws that will keep them from ever being very useful, despite their cleverness. How do we try to keep you current on important advances, yet weed out the losers?

Over the years, we've developed a guiding principle: Don't report on a new development until somebody who knows the field has thought it promising enough to spend some money to build and test the concept. That doesn't guarantee that it will succeed, but it does help eliminate the more marginal ideas. With that principle in mind, we decided in 1976 to keep watching Solchem, but to defer coverage.

A few months ago our patience paid off. The Naval Research Lab team had gotten enough money to build a receiver and install it at the solar-furnace test center at White Sands, N.M. There it successfully converted a gaseous carbon dioxide/methane mixture into an energy-rich product containing hydrogen, carbon monoxide, and steam. The energy captured in this substance could easily be converted back into heat. And the process, Mr. Chubb told us, worked even better than predicted. In addition, the second important element, a small eutectic-salts-storage boiler tank, had been built and tested at NRL, and a larger one was under construction. Clearly, the Solchem process was getting some serious interest—and financing—and early tests were showing that the calculations in that paper study we saw more than three years ago were valid. It was time to do the article.

Richard Stepler, who had been assigned to keep an eye on Solchem through the years, was dispatched to Washington to spend some time with Chubb and his associates. At the same time, the article seemed interesting and novel enough to consider as a cover subject, and artist Dean Ellis, whose last POPULAR SCIENCE cover in January showed the new high-technology cars, was retained to paint it. The story begins on the next page.

Running on hot air

Have you heard about the car that runs on the power stored in permanent magnets and uses no fuel at all? About the one that runs on compressed air; you only have to pump up the tank once, then it goes forever? The one that runs on water because a special carburetor splits the oxygen and hydrogen to fuel the engine?

Have you heard about the new carburetors that get two, three, or five times as many miles per gallon as the old carburetors? About all the devices that the car companies are just too stupid or too stubborn to use?

We hear about these "developments" constantly. We get letters from readers daily asking us why we don't cover them. Every time a local newspaper somewhere prints such a story, we are deluged with clippings from readers.

The first thing I should point out is that stories of this kind are not new. I remember my first such experience. I was a young reporter in a small southern town 30 years ago. A man came by and invited local reporters to a demonstration. He filled the gas tank with water, then dropped an aspirin-size pill into the tank. The pill, he said, converted the water into a high-energy fuel. He let anyone who wanted to drive the car around, and it certainly did drive like any other car. He explained that the pill was the invention of a brilliant scientist, but that the oil companies were trying to buy up the patents so that they could suppress the invention and continue to sell oil. But he had turned down millions from the oil companies.

I don't know how the guy made the car go. I suppose he had a small, secret gas tank hidden somewhere. But I am convinced that he didn't have a magic pill that made water into automotive fuel. And I'm just as sure that the current generation of secret-engine developers has not found any way around the basic laws of physics. There is no perpetual-motion machine that can create energy out of nothing. And it's very unlikely that there is any way to increase the efficiency of engines by enormous amounts.

You can certainly increase efficiency to some extent. Fuel injection, for example, is more efficient than carburetion since it delivers precisely measured amounts of fuel to the engine. We've printed articles in POPULAR SCIENCE about products that vaporize gasoline more fully and increase fuel economy. But these devices all make relatively modest improvements. Anytime you read about increasing gas mileage many times, you're probably hearing about a device that claims to get more energy out of the fuel than it contains.

Someday, someone may invent a far more efficient method of energy conversion than anything we know now. Someday, someone may succeed in finding new laws of physics that replace or supercede those we use now. But until someone can offer substantial proof that something of this kind has happened, we'll remain skeptical. We'll continue to keep an eye on developments and report those that seem promising. But we won't be impressed by the guy with the gas-tank pill, or by his modern-day descendants.

Next step in space

Even as it struggles to get the troubled Space Shuttle into orbit, NASA is moving into its next major project: construction in space of large, manned, permanent laboratories that would be used for research, manufacturing, and military-intelligence gathering. Several major aerospace companies have submitted conceptual designs. NASA is narrowing the field down to two, which will refine its plans for stations that could go into orbit in 1986.

Editor

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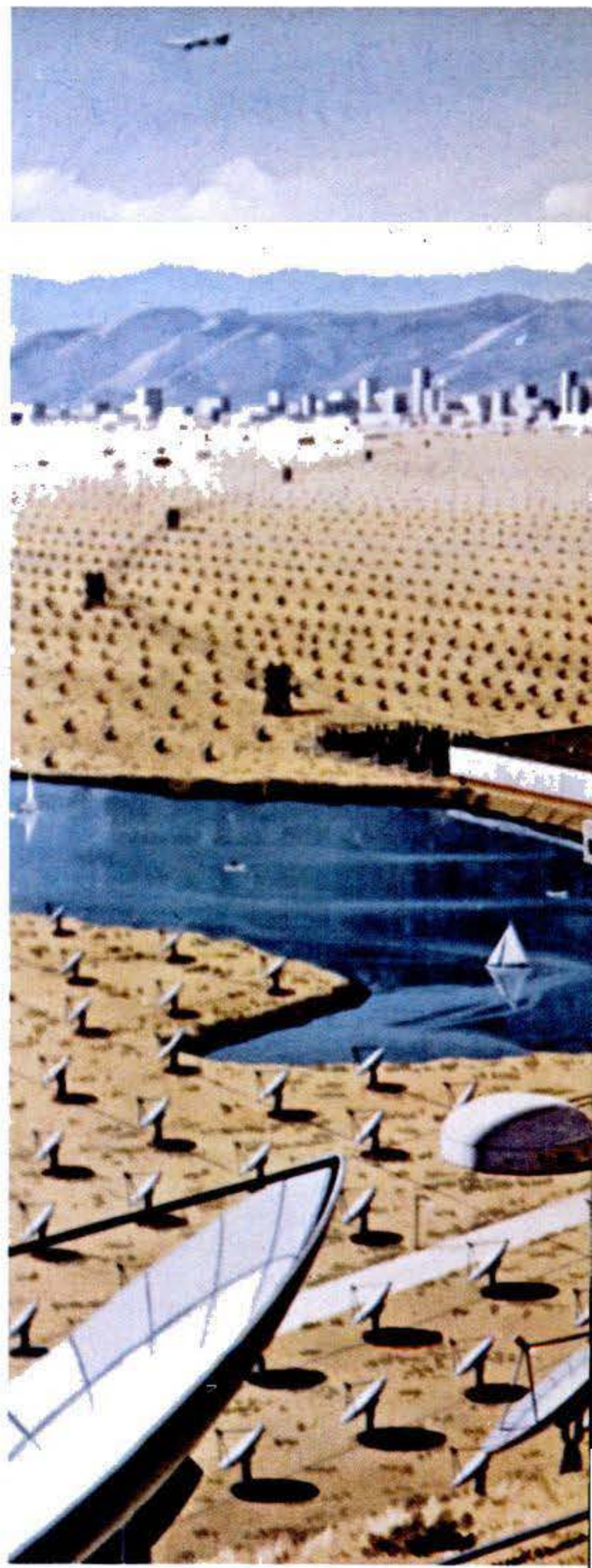
Solar collector/converter moves heat in chemical form



"Orchards" spread over the desert Southwest may reap the sun's energy

By RICHARD STEPLER

WASHINGTON, D.C.

I stood at a large window overlooking the Potomac River, holding a curious object: a curved length of spiraled ceramic tubing, about 18 inches long. It was a segment of a prototype for a thermochemical solar receiver such as the one pictured on this month's cover. This receiver/converter is a crucial element in a sophisticated system that promises to deliver high-temperature solar energy for large-scale power production.

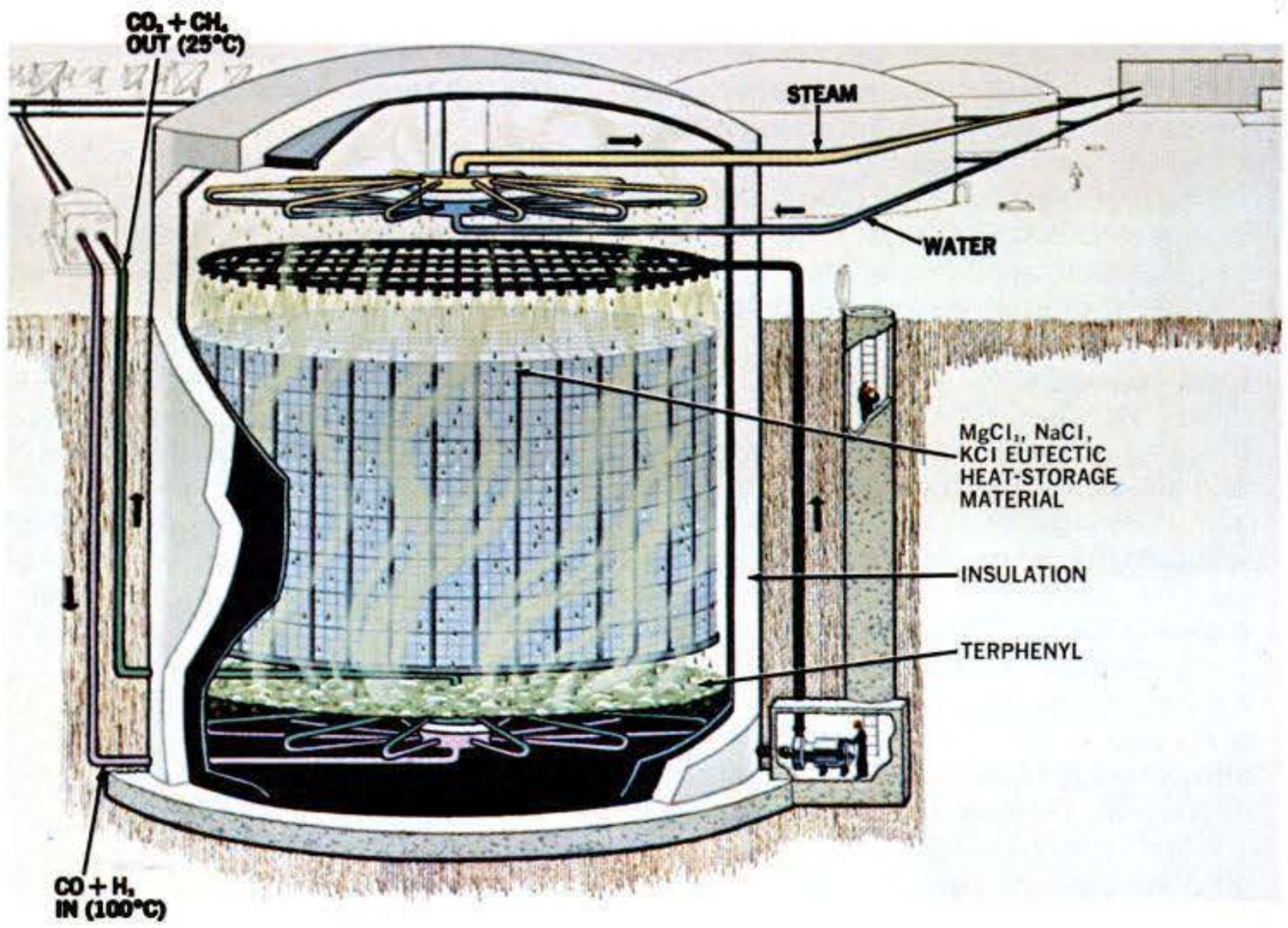
I was at the Naval Research Laboratory in the office of physicist Talbot Chubb, who, along with project associates Del Simmons and Joe Nemecek, was explaining Solchem, a novel thermochemical solar-energy transport and storage system.

In Solchem, a gaseous working fluid changes its chemical form in order to absorb, transport, and liberate solar energy in an endless, closed-loop system. According to Chubb and his associates, thousands of individual solar concentrators and receiver converters produce an energy-rich gas. Then low-temperature, low-pressure pipes carry the gas, which contains solar heat in chemical form, over intermediate distances—say, one tenth of a mile to 10 miles. (One gas being considered could even use plastic pipe!)

The sun's energy is gathered at a central power generating facility where energy-storage boiler tanks ensure that solar power is available whenever needed. The stored heat is used to produce steam to drive conventional turbines to generate electricity.

I'd been following Solchem's progress for several years. Two recent key developments indicated that it was time to report on the concept:

- At the White Sands, N.M., solar furnace, for the first time ever, a thermochemical receiver converted solar heat into chemical energy. ("It performed better than we predicted," Talbot Chubb told me with a grin.)



In Solchem storage tank, working gas recombines in piping at bottom of tank, releasing heat. Heat-pipe fluid terphenyl boils, condensing on cans filled with eutectic salt, which store heat. At night terphenyl is sprayed over cans to maintain high temperature and vapor pressure in tank. Energy is withdrawn in form of steam at top of tank.

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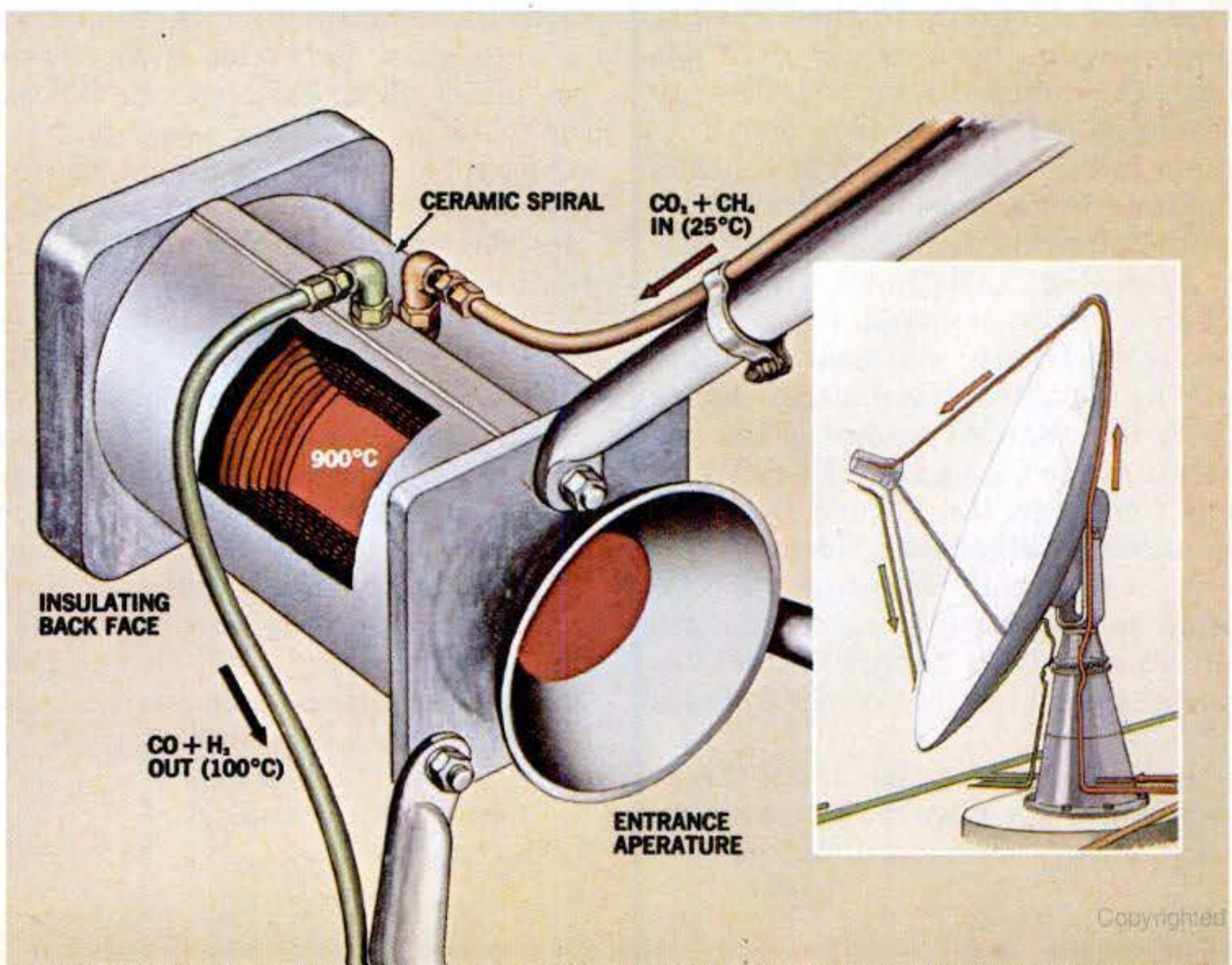
Solchem's solar-energy "orchard" would consist of thousands of paraboloidal concentrating collectors covering about 20 percent of orchard's land area.

Seven-meter-dia. (23 feet) paraboloidal collector concentrates sunlight onto thermochemical receiver/converter, which heats working gas to about 900 degrees C. Gas then passes over a catalyst and dissociates, absorbing heat.



• On the banks of the Potomac River in Washington, work on a two-MWh energy-storage boiler tank, containing 30 tons of eutectic salt, was nearing completion, with testing scheduled to be under way about the time you read this. (A smaller, laboratory tank has already been successfully demonstrated at NRL.)

Since I had just undergone NRL's mandatory security-clearance check, I

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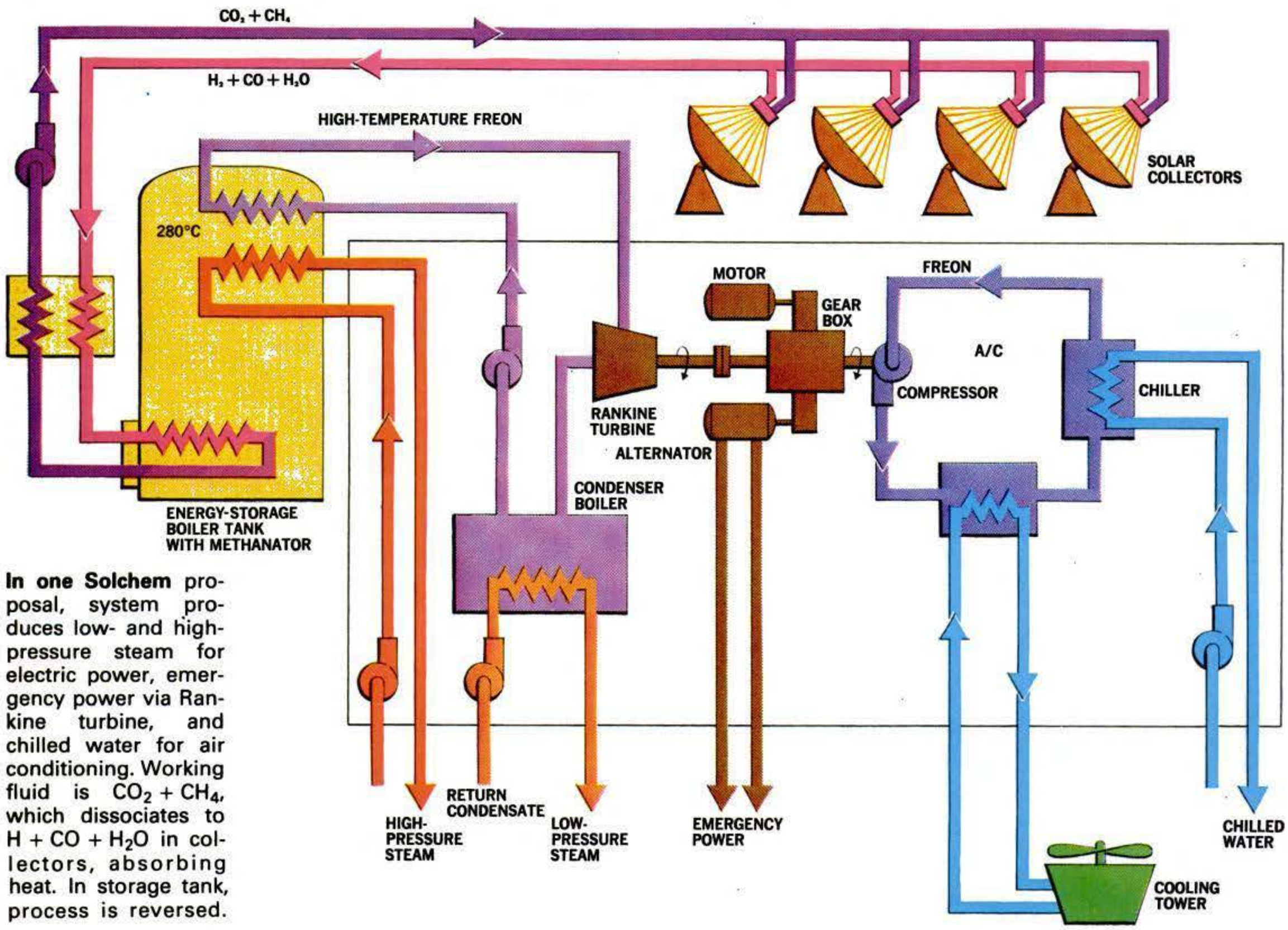
Solchem: thermochemical system for day/night solar power



In one Solchem proposal, system produces low- and high-pressure steam for electric power, emergency power via Rankine turbine, and chilled water for air conditioning. Working fluid is $CO_2 + CH_4$, which dissociates to $H + CO + H_2O$ in collectors, absorbing heat. In storage tank, process is reversed.

couldn't resist asking: Why was the Naval Research Laboratory—ordinarily involved in secret research on weapons and the like—interested in solar energy?

"If you think in terms of energy-collection orchards, 10 miles on a side, covered with collectors equivalent to 20 percent of the land area," Chubb told me, "and if you convert the collected solar energy to chemical fuel energy with an efficiency of 25 percent, the annual fuel production rate would be 0.12 quad per orchard." (A quad is the equivalent of 293 billion kWh, or the energy contained in 180 million barrels of oil.)

According to Chubb, the U.S. Navy's entire demand for energy—fuels, electricity, and heat—could be met by fewer than four such orchards, or by less than 25 percent of the real estate at the China Lake Navy Weapons Center in the Mojave Desert in Southern California. Solchem thus has the potential for freeing the Navy from dependence on coal, oil, and other nonrenewable energy sources—especially the kind that comes from the Middle East.

I also had a question about the ceramic receiver element I'd examined earlier: Why was an ordinary material such as fired clay being used as a crucial piece of hardware in so sophisticated a system?

"From the very beginning, we set strict ground rules," said Del Simmons. "We'd use only materials that are abundant in the United States, that are inexpensive, and that anyone can assemble and work with."

Since Solchem's beginning in 1973, the NRL team told me, they've been able to stick very closely to these guidelines. So it was no accident that the materials Solchem would be constructed of would be ordinary and inexpensive: materials such as plastic pipe, float glass, chloride salts, and ceramics.

Solar orchard

The basic concept of Solchem is rather easy to understand. "Imagine an array of solar-heated chemical processors scattered like orchard trees over the landscape," says Chubb. "Each processor is a small solar furnace that follows the sun like a sunflower, delivering an energy-rich product to the outside world." Of course, that's oversimplifying it; to fully understand Solchem you'll need to know a little chemistry.

The heart of the Solchem process is a thermochemical receiver/converter, mounted on a tripod at the focal point of a paraboloidal solar collector. The NRL team is studying many types of converter/heat exchangers, including the spiral-flow ceramic types illustrated here and on this month's cover. A working gas is pumped to the converter at relatively low temperature and is first heated in a counterflow heat exchanger by exiting gas. (This type of heat exchanger preheats incoming gas with gas that's being exhausted.) In the hottest part of the receiver—the cavity heated by focused sunlight—the gas undergoes what researchers call endothermic (absorption of heat) dissociation in the presence of a catalyst at about 800–900 degrees C. That is, it splits into two separate gases and absorbs heat.

The working gas, carbon dioxide plus methane (CO_2+CH_4), dissociates into carbon monoxide (CO), hydrogen (H_2), and low-pressure steam (H_2O). As this gas leaves the receiver, it preheats incoming CO_2+CH_4. Then it's piped to the energy-storage boiler tank at relatively low temperature (about 80 degrees C). The heat energy is contained in the gas in *chemical* form, not as sensible heat. (Compare gasoline, an energy-rich fuel that is

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far from hot to the touch yet burns at high heat to power vehicles.) Since the working gas is transported at relatively low temperature, lightly insulated plastic pipe can be used. Another working gas being considered—sodium trioxide (SO_3)—requires steel lines but can deliver very high-temperature heat (700 degrees C), as would be required for thermochemical fuel production.

At the central station, the working gas gives up as heat the energy captured in chemical form in the solar furnaces. First, the 80-degree-C gas is heated in a counterflow heat exchanger by 400-degree-C exiting gas. The heated gas then enters heat-release piping in the bottom of the energy-storage boiler tank(s), where the heat is released. The piping contains a catalyst that recombines the working gas ($CO+H_2+H_2O$ to CO_2+CH_4). This reaction occurs at about 400 degrees C and produces heat that is delivered to a heat-pipe fluid (terphenyl) contained inside the tank. The terphenyl boils and condenses on cans filled with eutectic salt.

"It works in the same manner that a pressure cooker delivers heat to vegetables—by evaporation and condensation of water," explains Chubb. Recombined CO_2+CH_4 returns to the solar furnaces, first passing through the counterflow heat exchanger to reduce its temperature to about 80 degrees C as it heats incoming gas. Further cooling lowers its temperature to 20 degrees C before its return to the solar collectors.

The eutectic salt—a mixture of sodium, potassium, and magnesium chlorides—shows little supercooling and appears to have unlimited life. This salt melts at 385 degrees C. [For more on eutectic-salt solar heat storage, see "Revolving Barrel Banks Solar Heat," PS, May '78, and "Solar Salts: New Chemical Systems Store the Sun's Heat," PS, Mar.]

During sunny days, when the system is collecting heat, the terphenyl is heated by the working gas. At night, the heat-pipe fluid is sprayed over the salt-storage cans, which then give up heat to maintain high temperature and pressure inside the tank. Energy is withdrawn—day or night—by piping water into steam boiler tubes in the top of the tank to produce 375-degree-C superheated steam to drive conventional turbines.

"All the energy you collect goes into storage," says Joe Nemecek, "and all energy comes from storage. So you have a load-following system." That means the solar energy is available whenever a utility needs it—during peak load periods, for example.

"In Solchem," explains Chubb, "power is generated from storage using a steam generator whose output can match time-varying demand. This means that the electricity can be used for peaking power, which has high market value, helping to defray high capital costs."

Why not store energy in the form of the energy-laden working gas that comes from the solar furnaces? "This might be feasible," says Chubb, "but it involves vast storage volumes." In fact, Chubb points out, by using the salts, storage-volume reduction is fiftyfold compared to storing the working gas.

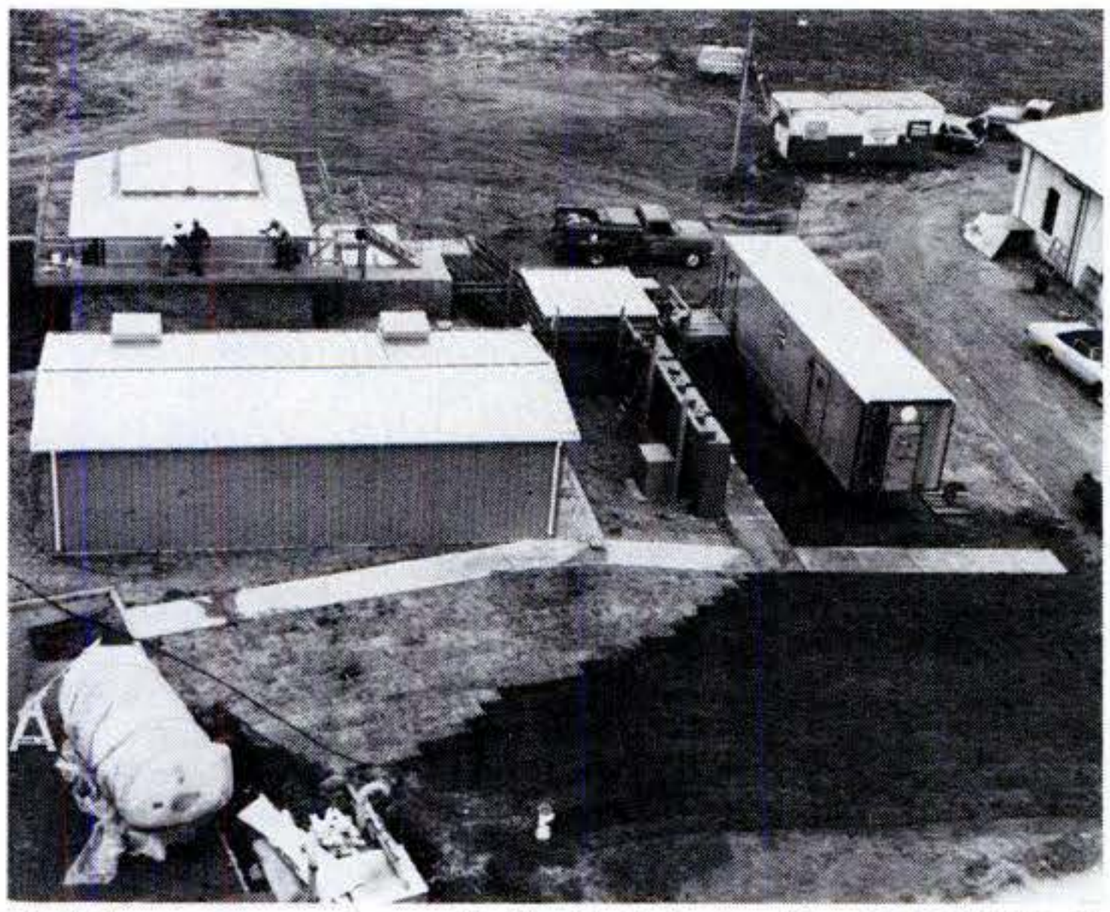
There are two complications with latent heat-of-fusion energy storage using eutectic salts: the salts' low thermal conductivity and the volume change that accompanies fusion. Chubb and his associates feel they've overcome these problems by packaging the salts in separate cans that are held in racks (see photo). "Volume changes associated with melting and freezing are confined inside each can so there is no bulk motion," says Chubb. "And heat flow into and out of the cans is achieved by using the heat-pipe fluid (terphenyl)."

Solchem's future

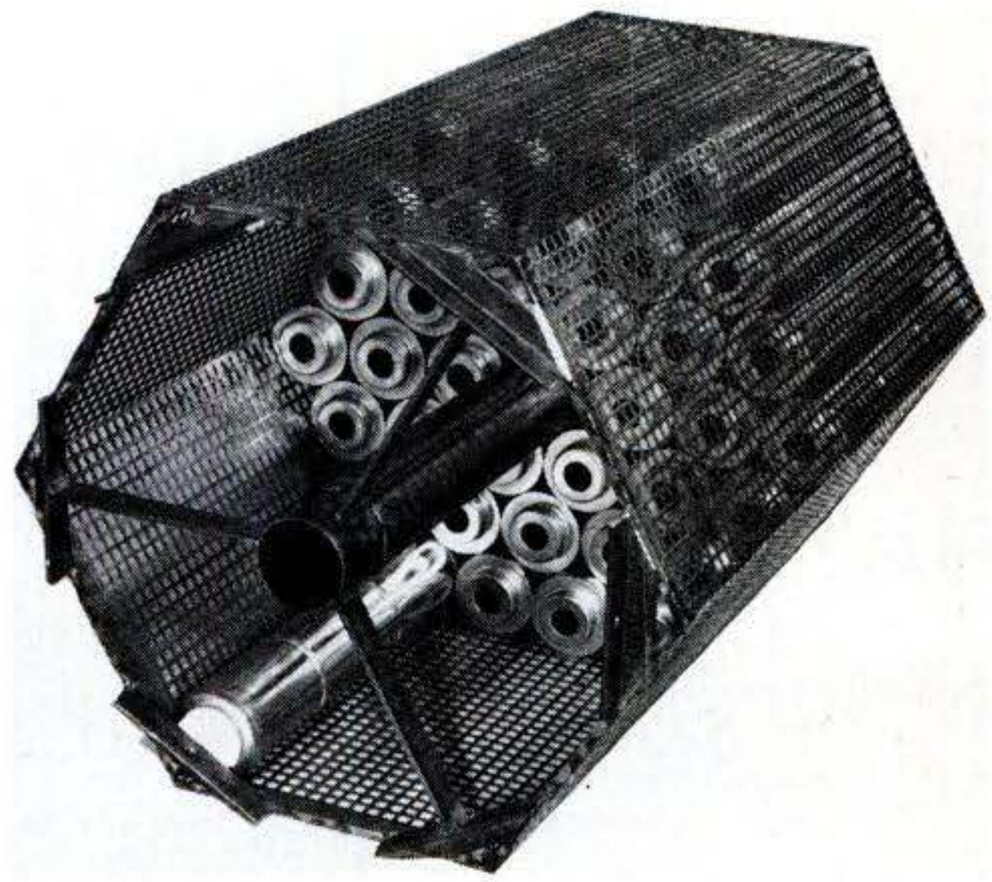
NRL team members told me that the Department of Energy, which is supporting the project, believes that the concept should eventually be turned over to industry. But the NRL team is hesitant to do so—at least at this time. "The program needs to be nurtured a little longer," Chubb says.

"What we want to do," says Nemecek, "is first demonstrate a two-collector plant, consisting of two concentrators with a typical transportation loop, energy-storage boiler tank, and some withdrawal—we'll make steam and generate some electricity with it, say, 25 kW." Once a plant on that scale has been successfully demonstrated, NRL hopes to direct a larger demonstration project with about 75 collectors. "We would expect," says Nemecek, "that at this point a utility will pick it up and carry it on."

When the Solchem project was first conceived in 1973, most people considered it a technology that wouldn't reach the hardware stage until well after the end of the century, say 2015 or so. In a scant seven years, Solchem has come further than anyone predicted. But Chubb adds a final caution: "The ultimate success or failure of chemically based processes for recovering solar energy will probably depend on our ability to construct inexpensive-enough components." So far, the NRL team is optimistic that it will succeed. PS



Prototype energy-storage boiler tank is nearing completion at NRL. Ten-foot-dia. by 12-foot-high Dacotherm-and-Foamglas-insulated tank will store 2000 kWh of thermal energy.



Eutectic salt is contained in 19-by-four-inch-dia. cans placed in racks inside tank (one shown above is partially filled). Storage tank will hold 60,000 pounds of salt.

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Free-piston engine

—will it power your car in 2001?

By JAN P. NORBYE
DRAWING BY DICK MEYER

I was standing in front of a test stand, looking at a tiny power plant about the size of a BMW motorcycle engine and weighing less than 70 pounds. It was much quieter than a diesel and was completely vibrationless, yet it was putting out an impressive 1.3 hp per cubic inch of displacement. Though it shares diesel fuel and compression ignition with diesel engines, it does not follow the diesel thermodynamic cycle, and so is not a diesel.

What I was looking at was a French-designed free-piston engine with a power-to-weight ratio three or four times that of today's auto engines. That alone could make it a strong contender for the auto engine of 2001. But what was so interesting about it was its unique method of producing *electric* power—power for propulsion—that would be transmitted directly to a car's hub-mounted electric motors, also newly designed.

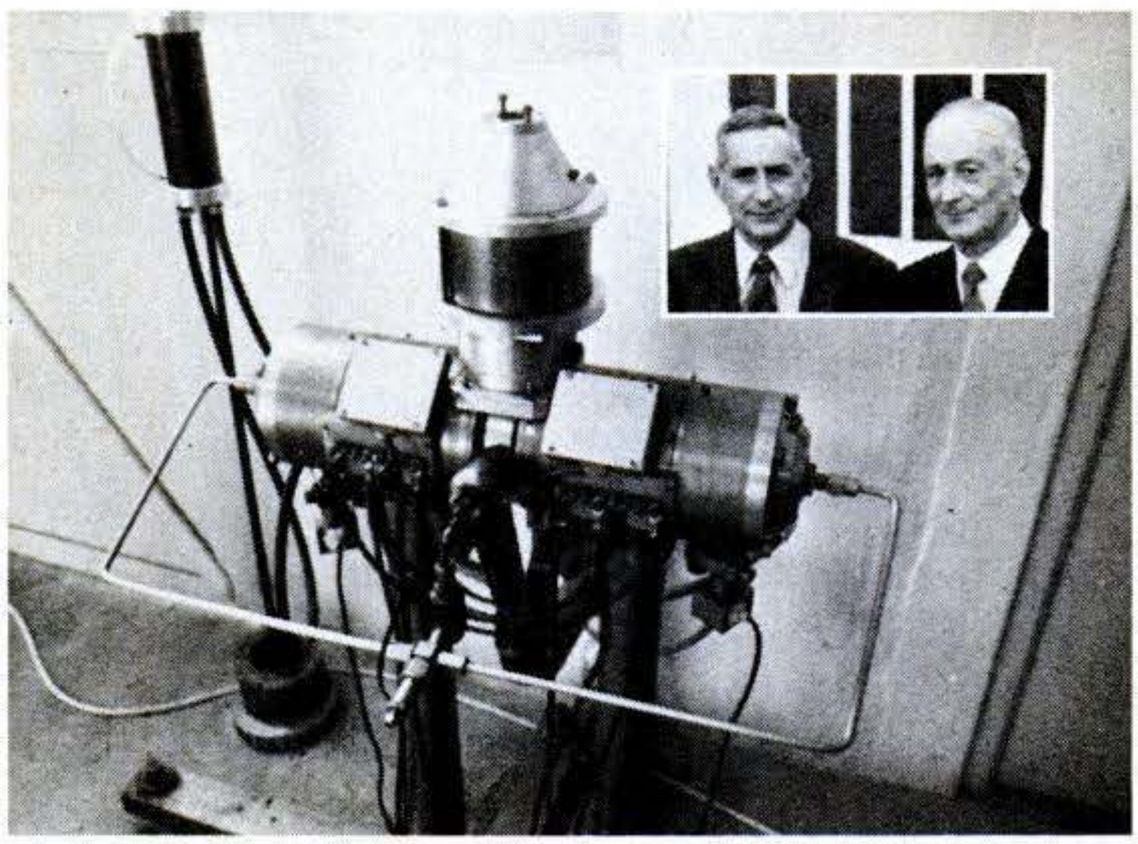
Both the engine and its companion motors are the products of the Jarret brothers, Jean and Jacques, professional inventors whose record of contributions to thermodynamics, mechanics, electromagnetics, and electronics goes back to 1947. They work in a large laboratory near Paris and originate most of their own projects. When they feel they have something well developed, they sell patent rights or licenses to industry.

The Jarrets work in secrecy and do not deal with the press. I was able to see them and their laboratory because of my acquaintance with Gerard Faul, an engineering director for Schneider S.A., one of three firms (along with Fabrique Nationale and Elf-Aquitaine) supporting development of the Jarrets' engine. Mr. Faul was instrumental in involving his company in it.

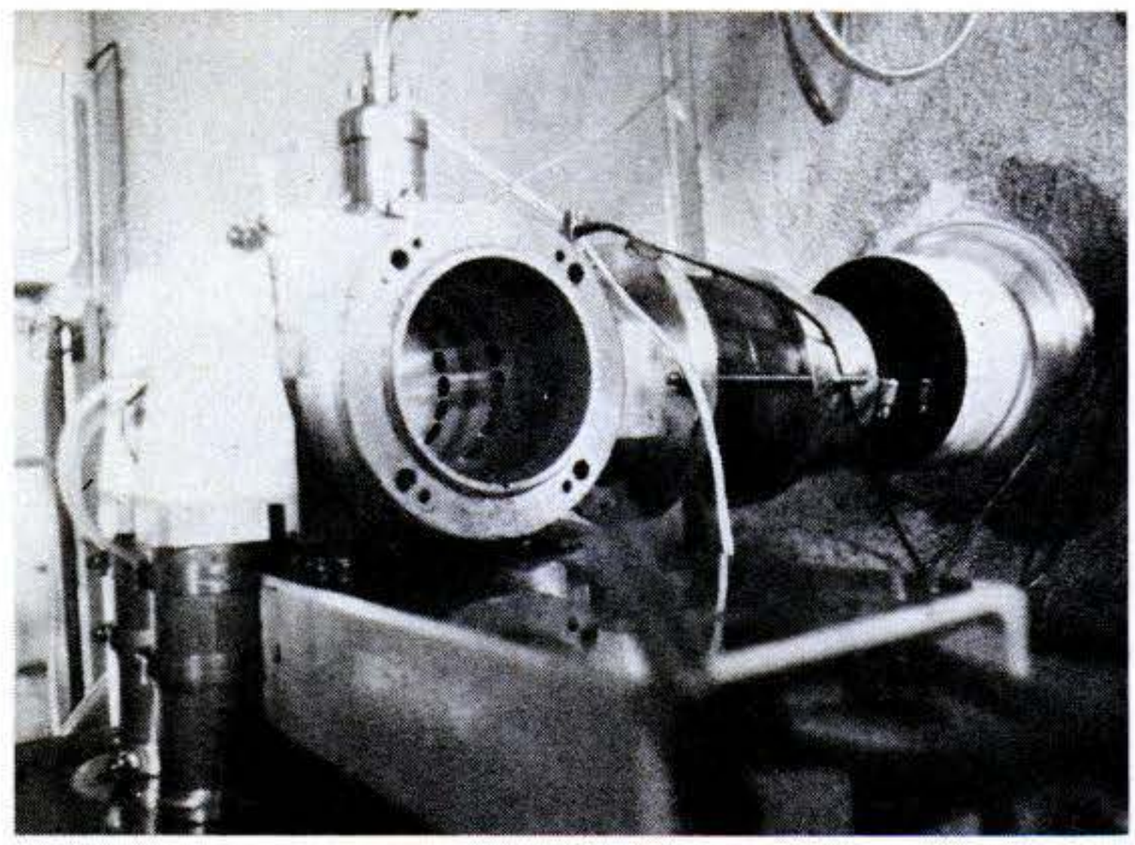
To understand how the engine came about, follow Jean Jarret's thinking. "I had to rethink the basic piston engine in terms of electronics," he told me. "Electronics did not exist when the Otto-cycle and diesel engines came into being. The industry is now adding electronic accessories to the same basic engines—but we set out with a pure electronic solution at the heart of the system."

The biggest change was the replacement of the connecting rods, crankshaft, and mechanical transmission by an electronically controlled electromagnetic system with a rectilinear alternator at each end of the engine. Direct fuel injection is used, and is timed to microseconds by an electronic control unit.

Exceptionally good fuel economy was a key part of the basic goals. "I am looking for 50 percent efficiency in the complete system," Jean says. That



One version of experimental free-piston engine is shown on test stand. Electric power is produced in inductor units at either end. Jarrets appear in inset—Jacques at left, Jean at right.



Details of combustion chamber are visible in this view of engine with inductor units removed. Exhaust ports can be seen in center; intake ports are fed from buttresses on left side of engine.

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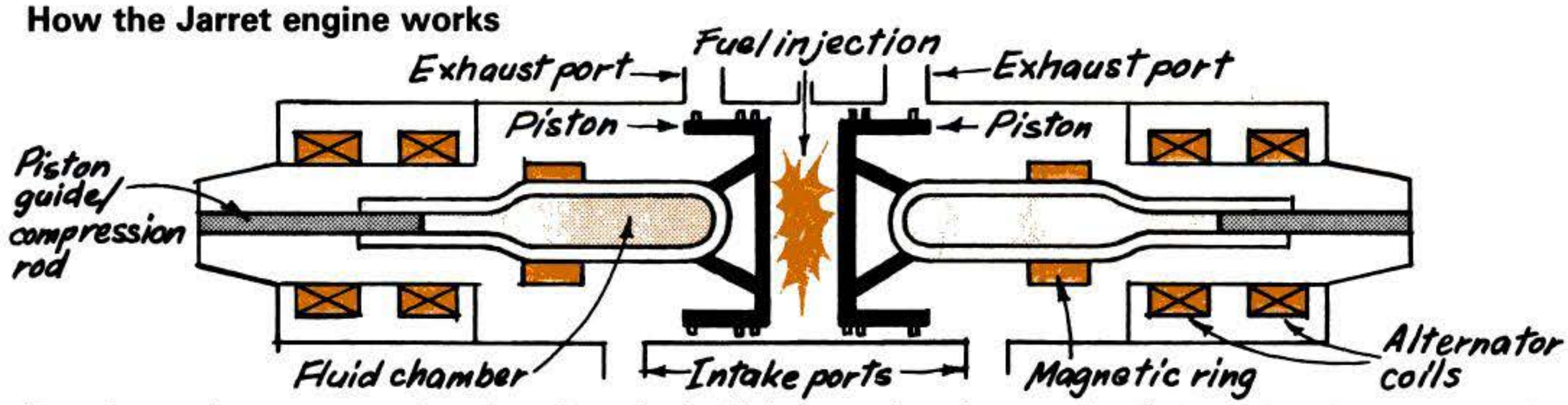
How the Jarret engine works



Two pistons share a common bore in this experimental engine, which has no valves. Gas flow is controlled by the pistons' covering and uncovering ports. Follow a complete cycle from combustion: Rapidly expanding gases propel the pistons apart and the exhaust ports are uncovered, where much of the expended charge flows out. Shortly thereafter, the intake ports are uncovered and the next charge is drawn in. As this is happening, piston-guide/compression rods at either end are forced into 100-cc fluid chambers, compressing the fluid as much as five percent for a "spring" action that propels the pistons back toward the center. Fuel is then injected and compression begins. As the pistons reach their inward limits, the compression ratio soars and combustion occurs (100 times as rapidly as in a conventional diesel), beginning the next cycle. In several of the Jarrets' test engines, the overall compression ratios range from 25:1 to 27:1. The final stages of compression, however, are much more severe. The mechanical movement of the pistons is converted to electrical energy by the magnetic rings on the piston assemblies passing between linear-alternator coils at the ends. Power would run motors to propel vehicle.

compares with 33 percent in a typical gasoline engine, and 40 percent in a good diesel. Both of these require torque multiplication—gearboxes and differentials—before their power can be used in motor vehicles. With the Jarret engine, the entire power-transmission system is reduced to wires to carry the current generated to the hub-mounted motors.

Jean showed me one of these lightweight motors. It had a large-diameter stator with the armature attached to and driving the hub directly—no form of gearing is needed. The whole motor assembly, he claimed, is no heavier than a normal disc- or drum-brake assembly. Power to the motors would be electronically regulated by a controller attached to the throttle.

When it came to designing the engine itself, Jean drew on previous research projects, which convinced him that energy loss in the combustion process varies directly with the square root of the time it takes to complete the burning, and that energy loss to the exhaust is proportional to the temperature of the exhaust gas.

These observations, combined with his reluctance to lower the peak combustion temperature, led Jean to the idea of reducing the cycle time at which temperatures are above 1200 degrees C. This is accomplished by a means Jean calls high volumetric detent ratio—the opposite of compression ratio. In practice, that means concentrating power production in one-thirtieth of the piston stroke, which has been found to reduce exhaust-gas temperatures from 1000–1100 to about 300 degrees C. It assures complete combustion and low emissions.

Jean further reasoned that the whole combustion period could be reduced to microseconds if compression occurred rapidly enough—a sudden and enormous rise in both temperature and pressure to release the combustion energy with explosive force in a minimum time. The opposed-piston layout of the engine assures this very abrupt rise in compression as the pistons approach inner dead center.

Like most diesel engines, it is regulated by varying the fuel input in accordance with the changing load; the greater the load, the more fuel used. Fuel injection takes place very early during the compression stroke and a very high percentage of exhaust gases is recirculated. "We get best combustion when using only 40 percent fresh air," says Jean. Tests indicate the combustion process is 90 percent efficient, instead of 70 percent for other internal-combustion engines.

Excited alternator coils

Converting the mechanical motion of the pistons into electric power is simple. Magnetic-ring inductors ride on the free-floating piston rods (whence the "free piston" name), each exciting two alternator coils in sequence. Both coils produce power—a regulated current at double frequency (320 Hz for the Jarret engine's constant cycle speed of 160 Hz). The coils on opposite ends of the engine are phased 180 degrees apart to provide continuous output.

What returns the pistons toward their inner-dead-center position is another Jarret invention: a "hydraulic spring." The piston rods on which the magnetic rings are mounted are hollow and contain a 100-cc fluid chamber on the piston end. A combination piston guide and hydraulic compression rod is forced into a special *compressible* fluid in these chambers, compressing it about four or five percent. The elasticity of the fluid stops, then repels the pistons back toward inner dead center.

The synchronization of this return is controlled electronically via the alternators. They sense any difference in movement between the two pistons and assure automatic correction of their symmetry.

For starting, the alternators are arranged to act in reverse, as piston-driving motors powered by a conventional battery. In this way, they set the magnetic rings on the piston rods in motion, which starts compression.

The brothers worked alone during the research and feasibility studies, and it wasn't until 1976 that Mothelec was formed to sponsor further development of the engine. Mothelec is a joint subsidiary of three firms: Schneider S.A., which is heavily involved in steel-making, naval constructions, and railroad locomotives; Fabrique Nationale, a Belgian company involved in arms production; and Elf-Aquitaine, the state-owned French petroleum company.

Today, Jean Jarret thinks it will take another 10 years to get the engine ready for production. Manufacturing studies have not even begun, but he points out that there are few parts and they are simple. There is none that cannot be machined on standard equipment, and there are no problems with materials or their cost. The engine can form a lightweight and compact installation for almost any vehicle, and would offer extreme freedom of choice for drive systems and layout. So, if normal development obstacles can be cleared, this engine just might power your car in 2001. PS

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Linear-track turntables
play records the way they were cut

Is a tone arm that moves a stylus in a straight line worth all that money?

By JOHN FREE
PHOTOS BY JOHN KEATING
DRAWINGS BY RAY PIOCH

Ever since the recording industry gave up the Edison cylinder and started putting recorded sounds on discs, records have been played back by the familiar tone arm that swings across the record in an arc, tracking the continuous spiral groove.

Today, a number of firms are introducing turntables of a different sort. The tone arm moves the stylus in a straight line along the record radius. These linear-tracking models duplicate the path made by the cutter-head stylus at the record factory. The result, claim the manufacturers, is the elimination of tracking distortion, cross talk between channels, anti-skating mechanisms, and groove damage—problems created when conventional arms must sweep the cartridge in an arc. Recently, I gathered together the models on the market at the time to see how they perform.

Linear-tracking turntables, also called radial- or tangential-tracking, have been around in limited numbers for some time. Aside from a few professional models, designs have been introduced and discontinued by Marantz, Rabco, and Schlumberger. Rabco marketed a tone arm for audiophiles that was difficult to set up properly. Harman/Kardon acquired Rabco and also produced a linear-tracking turntable—which also had technical problems. A string of model revisions produced the current ST-8—minus the electromechanical parts for arm tracking that created difficulties. Bang & Olufsen has offered linear-tracking models for years.

Besides these so-called straight-line turntables, several models with articulated arms have been sold. Like conventional turntables, these have a tone arm that pivots on a fixed base. A mechanism on the arm keeps the stylus tangent to the grooves as the arm moves across a disc. But the mechanisms inevitably add undesired bulk and complexity to tone arms. Garrard

Linear-tracking models (top, left to right): ReVox B790, Harman/Kardon ST-8, Bang & Olufsen Beogram 4004. Bottom, left to right: Aiwa LP-3000U, Technics SL-10, Phase Linear 8000. More models, available in Japan, may soon be sold here.

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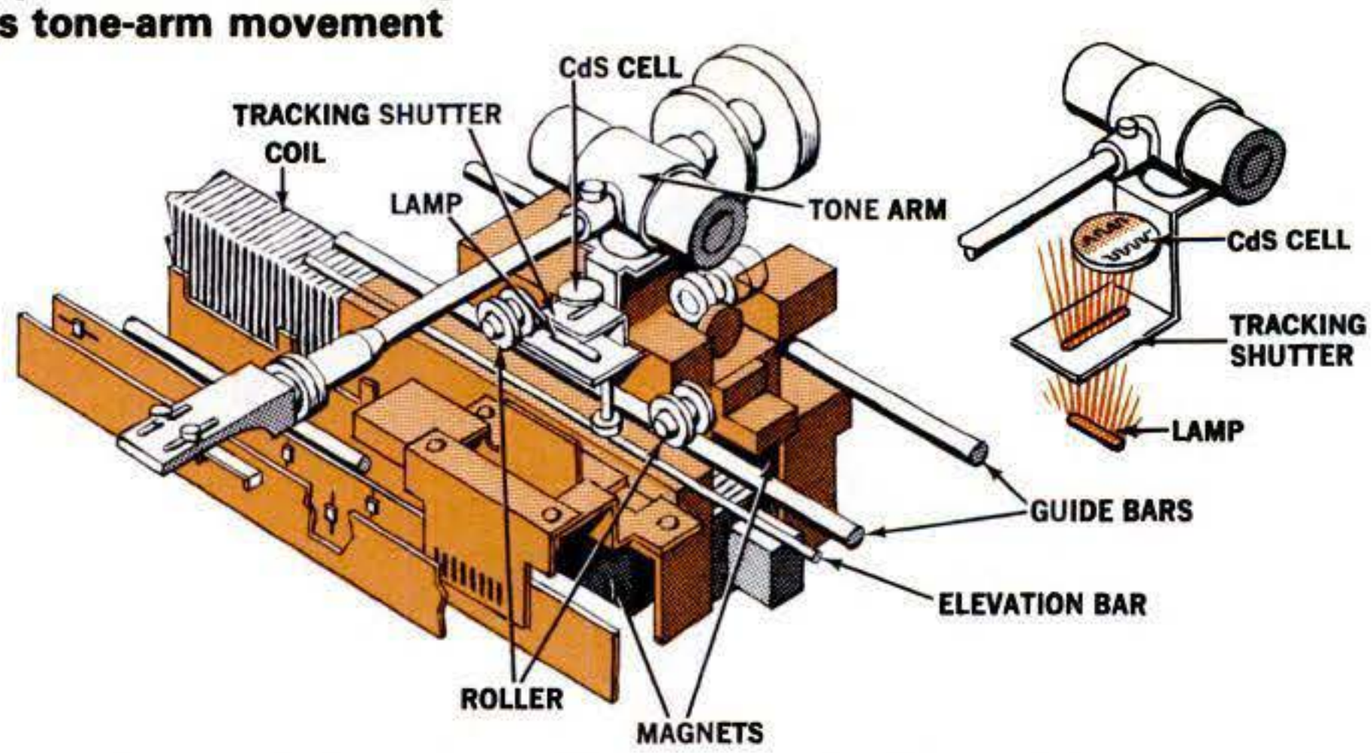
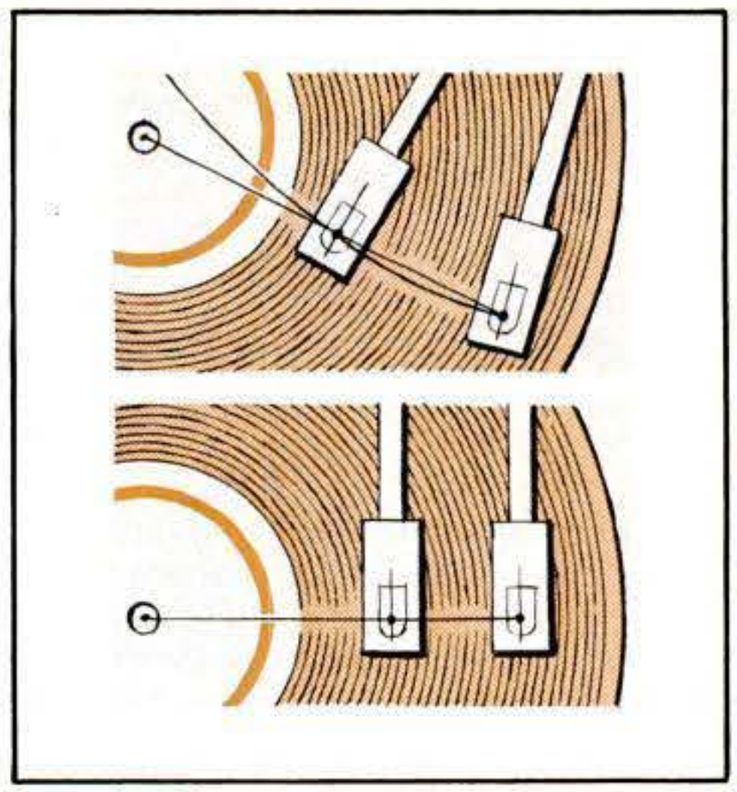
How opto-electronic sensing directs tone-arm movement



Sensing system in Phase Linear 8000 keeps tone arm at right angles to grooves. Tracking shutter (detail) is attached to arm and positioned between a CdS cell and lamp mounted on arm base. As stylus advances in grooves, arm pivots laterally slightly, so light passing through shutter illuminates halves of stationary cell unequally. The signal generated drives arm base until it "catches up" with stylus, lighting cell halves equally. Process continues as stylus advances in grooves.



Pivoted tone arms (top) produce angular tracking errors as stylus moves in arc, unlike straight line across disc radius made by master-disc cutting lathe. Linear or tangential-tracking arms (above) play records the way they were cut.

discontinued its Zero-100, marketed in the early 1970's, and the updated GT55.

Are there audible advantages to linear tracking? Is it worth extra money? Over the years, the supposed advantages have been controversial. I became convinced that linear tracking is superior when I participated in a listening panel several years ago. Using identical cartridges, two linear-tracking models, the Garrard 100 and a Rabco setup, were compared with a top-quality conventional tone arm, an SME. Other panelists and I consistently picked linear-track playback as "better" in blind A-B listening tests.

Low tracking error

What linear tracking eliminates is angular tracking error and the subtle distortion in sound it causes. Tracking errors develop when the cartridge and playback stylus are offset by a few degrees from the straight line produced by the hot cutter-head stylus forming the master disc.

With conventional arms, this angular error is generally reduced to zero only at two points along a disc radius. Longer conventional arms, sweeping a wider arc, minimize tracking errors over the entire width of the grooves. Short conventional arms, like those on children's record players, sweep a more curved arc and create high tracking errors.

Manufacturers of linear-track turntables specify tracking error to a tolerance of a few tenths of a degree from zero (tangency). But a few well-designed conventional turntable/arm combinations may also have less than one degree error across the entire radius of a disc. More often, though, the tracking error in most conventional arms is maximum (up to several degrees) in the innermost and outermost grooves, and between the two points along a radius where the error is zero.

If you install a tone arm yourself, and displace it from its ideal location by a few millimeters, tracking error is worsened. Similarly, installing a cartridge the wrong way may create severe problems.

Linear-track models, working properly, eliminate these angular tracking-error problems. They also do away with antiskating mechanisms, added to most tone arms to counterbalance the force applied to inner groove walls by the stylus due to the arm's pivoting action. Without this compensation,

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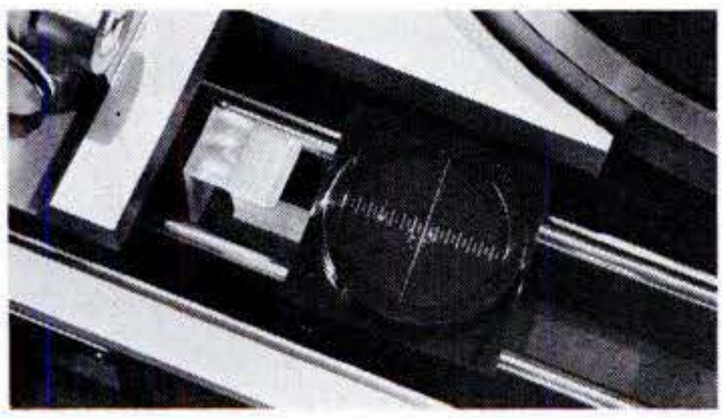
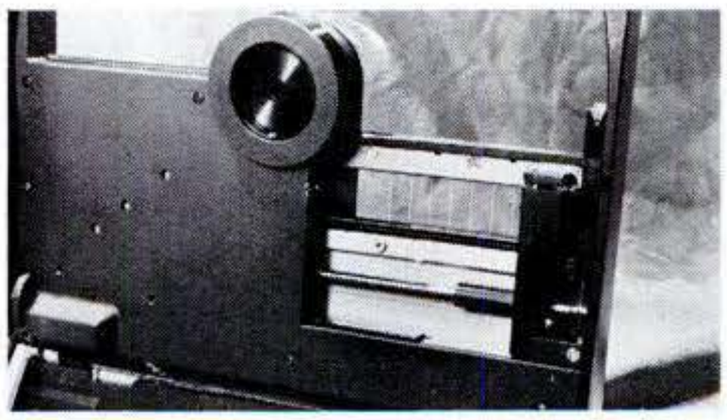


Bubble level shipped with Phase Linear 8000 insures guide bars are flat so arm resting atop linear motor does not slide.

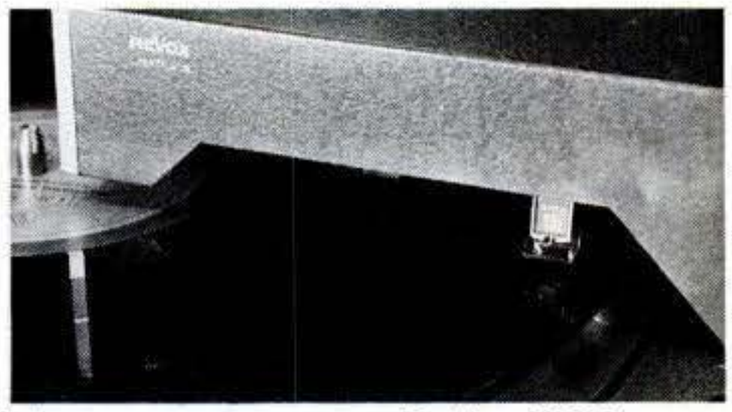


Flip-up lid on Technics SL-10 has arm with moving-coil cartridge (bottom right). Arm's tracking circuits are on the left.

Push-button row (left) on Aiwa's LP-3000U is used to program up to 15 tracks in any order for computerized play.

Remote-operation knob spins with a finger and lets you manually move Phase Linear 8000 tone arm across disc radius.

Record-sync jack on back panel of Aiwa 3000 can be used to start and stop a tape recorder as discs begin and end play.



Tone-arm support on ReVox B790 starts platter spinning when moved into place. Electronically guided arm is 1.6 in. long.

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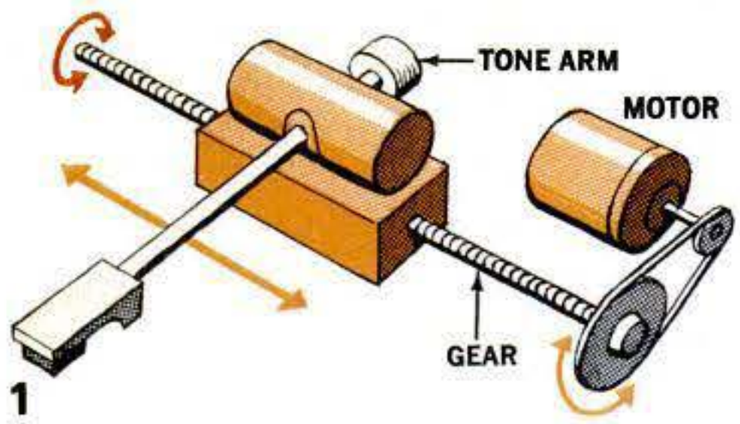
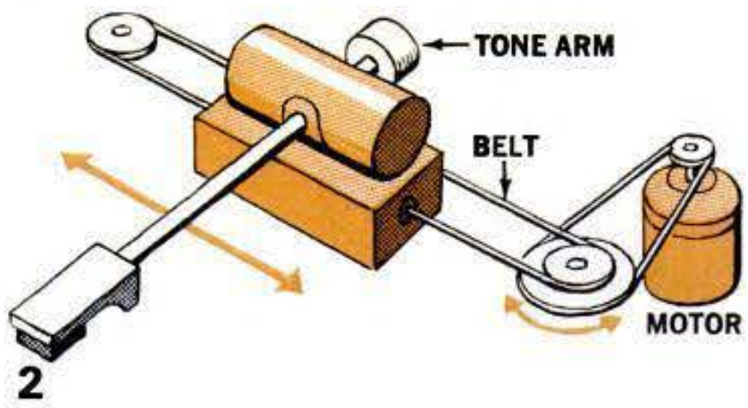
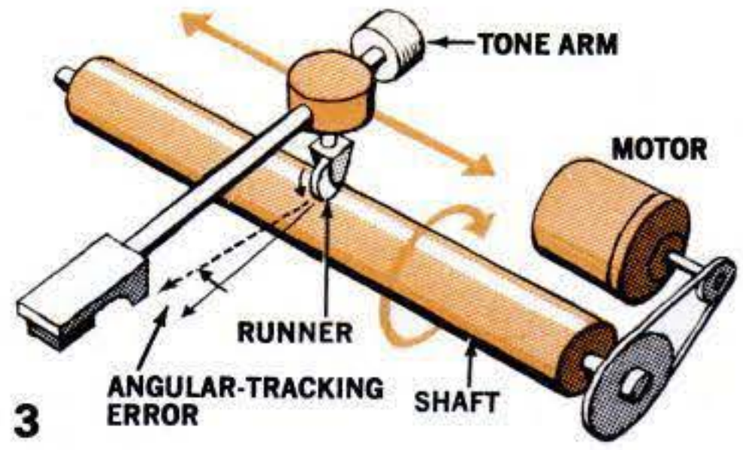
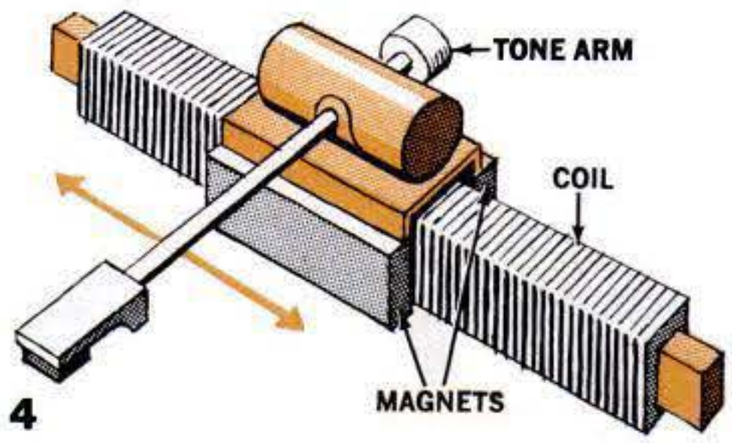
Four ways to drive linear-track tone arms









Smooth movement of the tone arm radially across the record is important for accurate linear tracking. Several techniques are used: (1) Gear—Bang & Olufsen's model and the newer Aiwa 3000 move the tone-arm system along a threaded gear. (2) Belt—tone-arm base is pulled back and forth by a cord. The arm base actually slides along rigid support rods. ReVox and Technics use this method. (3) Runner—this technique is used by Harman/Kardon. A runner wheel on the tone arm is biased (angled) so the arm moves toward the spindle as the shaft spins, acting as a threadless screw. Momentary errors that alter the bias angle produce correcting forces that speed up or slow the arm. (4) Linear motor—interaction between the coil and magnet fields moves the tone-arm base on Phase Linear model.

skating force can create audible distortion, plus unequal groove and stylus wear. Because of their nonpivoting design, linear-track models do not need antiskating compensation.

Linear-tracking models can also have a very short tone arm. The new $600 Technics SL-10 I've been testing uses this design advantage for some amazingly compact packaging: The SL-10 is no bigger than the dust jacket of a record, and only 3½ inches high.

Another new model from Phase Linear, a Pioneer subsidiary, has a tone arm moved by a linear motor (see diagrams)—similar in principle to those used to propel magnetic-lift trains [PS, Aug. '79]. Other new linear-tracking models are on the way from Japan, too. Prices range from about $400 to $1000, comparable to those of many conventional turntables.

I used Technics' new SL-10 for extended listening tests to try out this ultracompact, microcomputer-controlled model and to check out a criticism of its arm-drive method: It has been claimed that linear-track designs using a rotary motor to move the tone arm radially (see diagrams) couple significant amounts of noise and vibration from this motor into the stylus, and that this results in more audible noise (reflected in rumble specifications) than with a nonrotating linear motor.

Turntable noise?

Using wide-range direct-to-disc recordings, however, I found that the SL-10, with its ultrashort cord-driven arm, produced absolutely no audible background noise. If you're comparing turntables, these discs will insure that the model and cartridge you select tracks grooves during wide stylus swings (loud passages). You can check for background noise on very quiet passages, or use the silent groove on an audio test record. If you have many warped records in your collection, make sure a linear-track machine can play them, too.

One linear-track model offers an extra feature you may or may not need. Aiwa's LP-3000 has an infrared LED and phototransistor in its cartridge shell. With a sensor circuit, this combination can detect blank intervals between disc bands. The 3000's microcomputer stores preselected bands by number, so sensor and computer working together can pick out and play bands in random order. (Technics' SL-10 has an optical sensor near its stylus tip, but its function is to sense the tone-arm position and minimize tracking error.)

Features such as button-operated fast advance or reverse for the tone arm, available on all models but Harman/Kardon's ST-8, should be compared in stores along with other operating conveniences. PS

PS buyer's guide to linear-track turntables

Mfr./ brand	Model	Price ($)	Tone-arm drive	Cartridge included	Platter drive— belt (B), direct (D)	Motor-speed control	Speed accuracy (± %)	Auto disc-size selection	Wow and flutter (%)	Rumble (dB)	Tracking error (± degrees)	Size (WHD) (in.)	Weight (lbs.)	Comments
Aiwa	LP-3000U	999	Gear	No	D	PLL (A)	0.003	No	0.025	<-73	0.25	18⅞ × 5⅞ × 17¼	34	Stores up to 15 tracks in computer for automatic play; infrared sensor in cartridge head
Bang & Olufsen	Beogram 4004	850	Gear	Yes	B	Tach-ometer (B)	0.02	Yes	<0.025	<-65	<0.04	19.3 × 3.9 × 14.9	24	Remote-control operation with 2400 receiver. Detector arm (lamp/photocell) senses disc size
Harman/ Kardon	Rabco ST-8	399	Runner	No	B	Hall (C)	0.3	No	0.03	-65	0	16½ × 6¾ × 16¼	23	Cueing arm. Built-in bubble-level indicator. Low-friction rolamite-type vertical bearing on arm
Phase Linear	8000 series II	750	Linear motor	No	D	PLL	0.002	No	<0.013	-78	0.2	19.4 × 6 × 17½	27	Hanging-rotor motor locates bearing near platter (claimed to eliminate "platter wobble")
ReVox	B790	899	Belt	Yes	D	Quartz (D)	0.01	No	<0.05	<-68	<0.5	17.8 × 5.6 × 15	24	Cartridge change or stylus replacement by ReVox suggested. Cartridge-mounting kit available
Technics	SL-10	600	Belt	Yes	D	PLL	0.002	Yes	0.025	-78	0.1	12½ × 3½ × 12½	14	Switch-selected amplifier for moving-coil cartridge. 45-rpm adapter pops up automatically

Notes: Specifications provided by manufacturers. A—Phase-locked-loop circuit locked to quartz oscillator. B—Tach-controlled DC motor has built-in generator, its frequency dependent on motor speed. C—Hall-effect elements in motor provide output for speed regulation. D—speed referenced to quartz oscillator

MANUFACTURERS' ADDRESSES

Aiwa, 35 Oxford Ave., Moonachie NJ 07074; **Bang & Olufsen,** 515 Busse Rd., Elk Grove Village IL 60007; **Harman/Kardon,** 55 Ames Ct., Plainview NY 11803; **Phase Linear,** 20121 48th Ave. W., Lynnwood WA 98036; **ReVox,** 1819 Broadway, Nashville TN 37203; **Technics,** One Panasonic Way, Secaucus NJ 07094.

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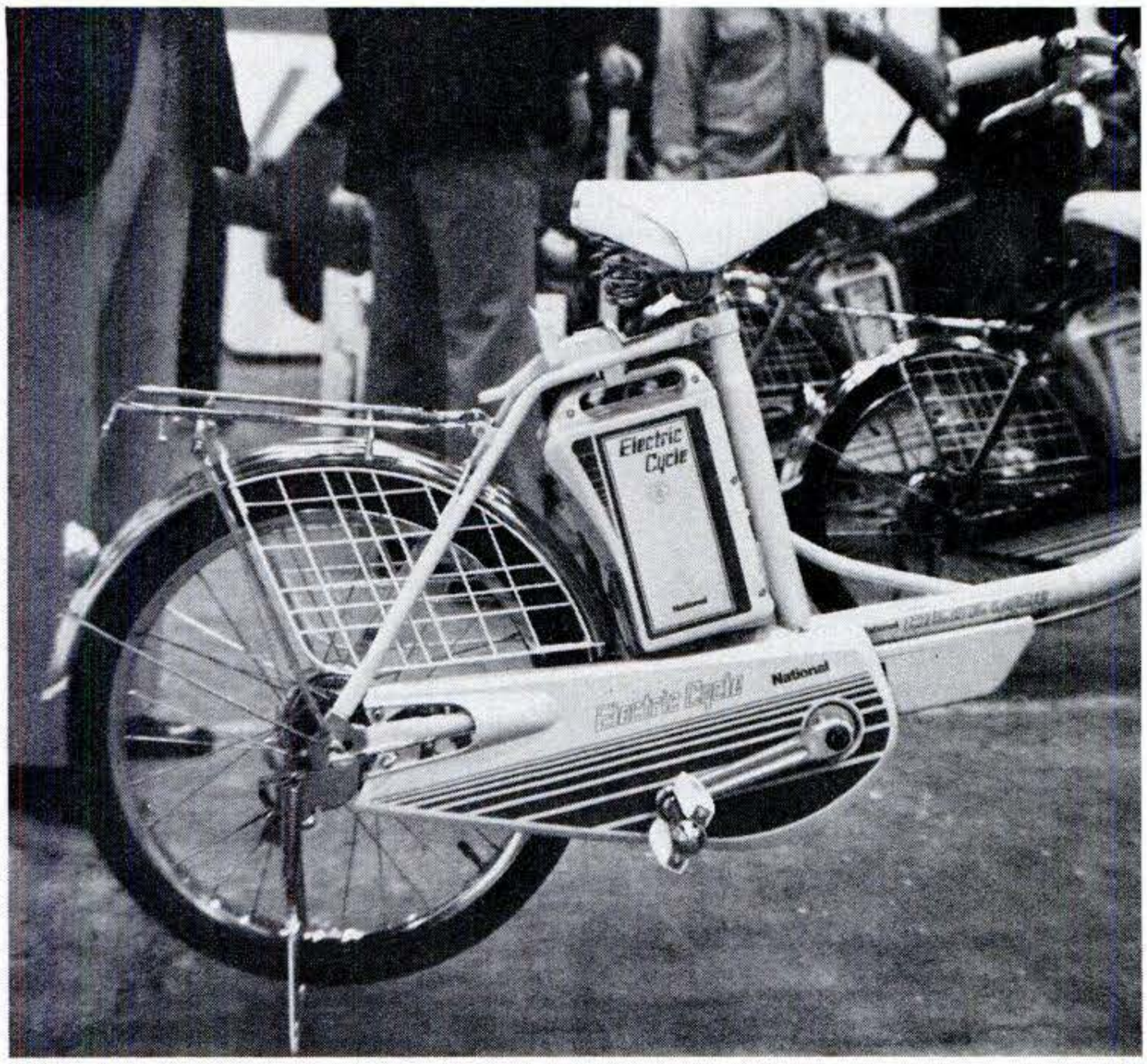
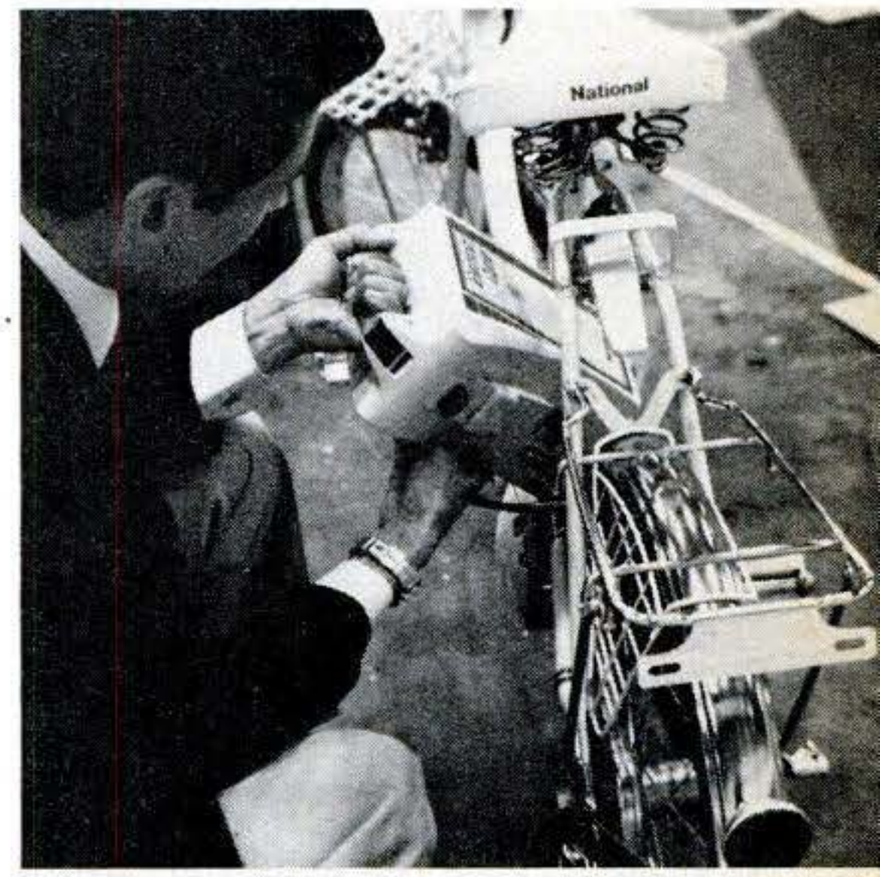
New electric bike

hits 18 km/h

Author gets a push from the 80-watt electric motor that is geared directly to the rear wheel. Pedals are for steep hills.





Battery pack easily removes from under seat for recharging or exchanging. Pack holds two 12-volt lead-acid batteries.

Pop-in power gives you an hour's riding time

By BEN KOCIVAR

TOKYO, JAPAN

Climbing costs of gasoline have many people taking to bikes who never considered them seriously for transportation before. But some people, not interested in working up a sweat to get to their destination, would appreciate a quiet power assist. In Japan I recently drove a neat prototype electric bicycle that provides an answer.

The idea of an electric bike is hardly new, but this design, developed by Matsushita Electric Corp., has some novel features. It's lively and fun to drive.

I've seen American versions that are conventional bikes with a small electric motor bolted to the front of the frame to power the front wheel by a roller contacting the tire. This one, however, has a new flat 80-watt 24-volt DC electric motor neatly fitted behind the conventional pedals where it is geared directly to the drive chain powering the back wheel. The compact lead-acid two-piece (12 volts each) battery locks behind and under the seat in an easily removable case and provides 24 volts for an hour's operation. Maximum speed is 18 km/h; maximum distance possible on a single charge is 18 km at a speed of 15 km/h—and I found that's plenty of speed and distance for a bike that is basically designed to let you pedal comfortably, as well as tool along under electric power.

The bike has conventional hand controls for front and rear brakes. The "throttle" to the electric motor is a simple on/off white button comfortably located under the left thumb of the handlebar. There is a two-position gear shift on the right handlebar that lets you do 18 km/h top speed on the flat. But shifting down changes gear so that the 31-kg machine can climb a 10 percent grade (if the hill gets steeper you can assist with pedal power).

Once fully discharged, the battery takes about 10 hours for a complete recharge using a small converter that can plug into a normal house outlet.

The big questions that led me nowhere were how much and when? The bike I rode was one of about 50 prototypes now being used for testing, and while I was told a production version might be marketed within a year, there was no indication of how much it would cost.

For ballpark reference it's worth noting that an American company, Pedalpower, of Sewell, N.J., offers two- and three-wheelers with front-mounted motors at prices ranging from about $130 to $555. PS

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Semi-submerged cat

takes bumps out of waves

Underwater floats slice through waves for a smooth ride

By BEN KOCIVAR

CHIBA, JAPAN

In the sprawling shipyard of the Mitsui Engineering and Shipbuilding Co. near Tokyo, the 34-m (111.5 ft.) ship was dwarfed by monster oil tankers and huge merchantmen. Her broad beam and square lines lacked the grace of conventional fast ocean liners. Yet, walking up the makeshift gangplank, I felt I was boarding the ship of the future.

The Mesa 80, the world's first commercial semi-submerged catamaran, is no ordinary ship. That she's a catamaran, with high twin hulls connected by a wide deck, is plain to see. What's not so obvious are the torpedo-like tubes under each hull. These submerged floats provide buoyancy and stabilizing forces. The Mesa 80 can speed at up to 27 knots through rough waters—without the limitations of conventional monohull ships.

Despite her relatively small size, Mesa 80 is seaworthy enough to provide smooth, stable rides in 11½-ft. waves. Such stability in high waves makes the catamaran much less susceptible than monohulls to being slowed by storms. This translates to greater economy of operation and reliability, despite the weather.

Ten-year project

The Mesa 80 is the culmination of basic research that Mitsui, along with the Japan Marine Machinery Development Assn., began in 1970.

The team first built an experimental version, the 39.4-ft., 29-ton Marine Ace (see photo). It could speed at 18 knots and navigate in moderately rough seas.

Before they built the Mesa 80, I learned, the Japanese consulted Dr. T. G. Lang of the Naval Undersea Center, San Diego, Calif., inventor of the concept.

The basic design of the 570-ton Mesa 80 is much like the U.S. Navy's SSP Kaimalino, a 190-ton ship used as a stable support vessel for deep ocean research in the rough waters off Hawaii [PS, Dec. '75].

But this commercial semi-submerged cat is designed as an ocean-going ferry. (There is another commercial vessel based on the submerged-hull concept—the 88.6-ft. Dolphin [PS, May '76] which is used for tourist rides in the Dutch West Indies. But that craft looks more like a party boat than a seagoing vessel.)

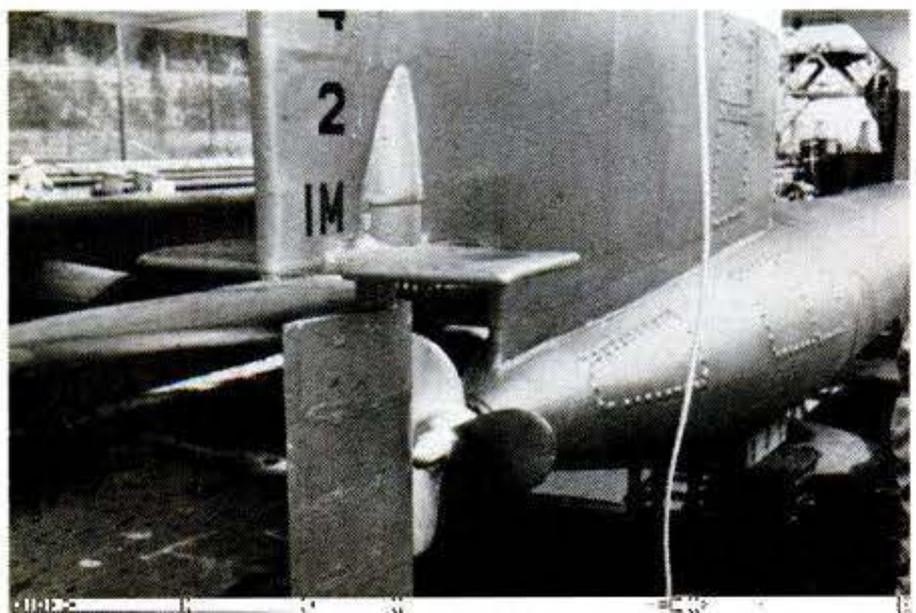
The huge Mesa 80 will carry tourists from the resort city of Atami, north of Tokyo on the east coast, to Oshima Island, a tourist spot 40 miles off the coast in the Pacific Ocean. Its speed and stability are designed to provide service nearly 100 percent of the time, even in the heavy sea conditions of Japan's coastal areas.

Futuristic flotation

Standing beside the giant cat at dockside, I peered down at her submerged floats. My host, N. Hayashi, explained that the hulls, divided into five interconnected compartments, are ballasted with seawater to stay about 4.6 ft. under the water surface. These 6.5-ft.-dia. hulls expose a relatively small waterline area to wave action, thus effectively reducing its force. Since the ship is less affected by waves, it doesn't lose much speed pitching up and down.

Stabilizing fins on the hulls, actuated by an autopilot in the bridge, positively control ship motion in waves, to maintain level "flight."

A propeller at the stern of each underwater hull is linked via Z-drive to a pair of Fuji-S.E.M.T. marine diesel engines of 4050 PS (metric horsepower) each at 1475 rpm. (By comparison, the U.S. Navy version uses two gas-turbine engines and a series of chain



Stabilizing fin (right) mounted on inner side of the aluminum alloy hull is one of a set of four. Each hull has a fin placed inboard just forward of the rudder (left) and one mounted at extreme forward end of the hull. Controlled from the cockpit, movable fins keep craft from rolling in heavy seas—a boon for seasick-prone passengers.

High-riding catamaran speeds on submerged floats that give a smooth ride even in rough weather. The ocean-going ferry carries Japanese tourists between island resorts. Giant faired exhaust stacks at midstation rise high above the top deck, keeping diesel fumes well clear of the huge, enclosed passenger lounge on the main deck.

drives to bring the power down to the props.)

Once aboard the vessel, my guide led me first to the passenger deck. Entering the cabin felt like walking into a superwide jumbo jet. Fitted with airline-type seats, the large one-level deck accommodates 446 passengers.

We then moved on to the enclosed control cockpit, or bridge, at the head of a wide, open cargo deck above the passenger compartment.

On the bridge, Hayashi showed me the simple controls. There are two conventional throttles, as well as large toggles for trimming the underwater stabilizing fins and an elevation control to set the exact depth for the submerged hulls. Normally, the craft draws 11 to 12 ft., but this can be adjusted depending on wave height. What's important is keeping the underside of the deck up high enough to avoid pounding waves. It's also important to keep the submerged hulls from breaking out of the water and pitching up and down.

Versatile cat design

While this first commercial use is as a high-speed, deep-water ferry, the submerged-catamaran design offers many other possibilities. Hayashi told me that North Sea oil-rig operators were interested in the boat for shore support operations now being supplied by helicopter and slow conventional ocean boats.

The wide deck space and shallow draft of the design also make it attractive as a container ship and as a helicopter platform for navy and offshore patrol work. And the stability that the widely spaced hulls provide makes it ideal for an offshore work vessel.

Finally, the Mesa 80 concept is an obvious head-on competitor to the hovercraft and hydrofoil, both of which go faster than the submerged catamaran, but both of which are considerably more expensive to make and operate.

Starting service this year, the semi-submerged cat is opening exciting new horizons for seagoing vessels. PS

Drydocked prototype, the Marine Ace, was the smaller test vessel built before Mesa 80. To refine its unique, semi-submerged catamaran design, Mitsui Co. first built a number of smaller models, including a 2.75-meter (nine foot) craft. These powered craft were wind-tunnel-tested and monitored in wave tanks before being proved on open waters.

Massive passenger cabin, designed like a superwide-body jet, seats 20 across and has four aisles running fore and aft. Without the cabin, the Mesa 80's broad deck could serve as a helicopter landing pad, container cargo hold, or offshore work platform.

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6-foot projection TV
you build from a kit

A bright, sharp picture, eight times larger than normal, makes TV viewing a new experience

By BILL HAWKINS
PHOTOS BY JOHN KEATING

My family and I used to simply watch television; now that I have built Heath's new big-screen projection TV system we get involved in it. Heath's kit-built giant, six-foot-diagonal picture turns normal TV viewing into a night at the movies.

At $2195, it's not one of those low-budget projector kits that have been around for years. It doesn't produce a low-budget picture, either. Image quality is excellent. Sharp, colorful, evenly bright pictures make it comparable (to my eye) to the most expensive projector models.

Be forewarned, however, that this is not the usual home "appliance." As I found out, it not only changed my family's TV viewing habits, but changed the interior of my home, as well.

The kit

One look at the four huge boxes of parts you start with will tell you that the GR 4000 is not a simple bolt-the-lens-to-the-TV kit. It's a complete projector system that uses three projector tubes (one for each color) that focus their images through a refractive lens to the distant screen [See "Giant-Screen TV," PS, May '79].

The two benefits of producing a giant image this way are brightness (there is no shadow mask to keep the colors separated, as is needed in a conventional all-colors-in-one picture tube) and sharpness (since the three colors are mixed—converged—right at the screen). The 4000 system enhances the picture even more by using a very fast lens (f/1) for more brightness and a high bandwidth receiver (4.08 MHz) for better resolution. The result is a great picture—and a kit you'll never forget.

The GR 4000 is a typical Heathkit; if you can read, you can build it. The instruction book is that good. The critical items—projection-tube bulkhead, high-voltage power supply, and tuners—are preassembled. All you do is mount them in place and solder the connecting wires.

For the rest, however, get ready to spend some time. It took me 66 hours to complete the unit and another 15 to set up the screen and align the circuitry.

Most of the components are mounted on individual circuit boards. Then each board is tested (using a meter supplied in kit form) and inserted into the main chassis (see photos). You also perform some initial voltage tests on the unit, and if anything isn't quite right, you can go into another handbook, "In Case of Difficulty," to narrow down potential problems.

When I first turned on the projector I saw absolutely nothing on the screen. The first hour of setting up the system is hardest on the nerves, since you don't know whether to expect the "Movie of the Week"—or smoke. Soon, however, I had worked my way up from a poor, all-green picture to a fair multicolored one. The next step, and one that would take me another eight hours, is convergence.

Since each projector tube emits its own single-color image on the screen (red, blue, or green), all three images must coincide precisely for the colors to mix and form the proper color being broadcast. To help you converge the picture properly, the projector has a built-in crosshatch generator. Flip a switch on the front panel and a series of horizontal and vertical lines appears on the screen. The instructions then take you through a number of steps you perform over and over until the lines become as white as possible. You can't get them perfect, but the more persistent you are, the sharper the picture will be when you finish. Suggestion: Do it a couple of times to get used to the controls, but don't be fussy at first. Let the set "break in" for a few days, then get down to business. I noticed some big changes after break-in and had to do it all over again.

Not just a TV

I found out quickly that the GR 4000 is not just another appliance in my home—its size and required placement (seven feet from the front of the screen) mean you must plan for it. The box is on casters, so you can roll it out of the way when not in use, but it's not the kind of thing you can hide in a corner. For that reason, I decided to use it as a permanent piece of furniture in the room and arrange tables, chairs, and lighting to work with the projector and screen.

Wiring is a problem; AC power, the antenna cable, and VCR connections could become a hazard if just laid loosely on the floor in a dimly lit room. To solve that problem, I installed a connector panel in the floor and wired everything from the basement. The connector approach is a good idea, too, if you decide to roll the projector out of the way routinely. Just unplug and stow.

Selecting the right place for the

Continued

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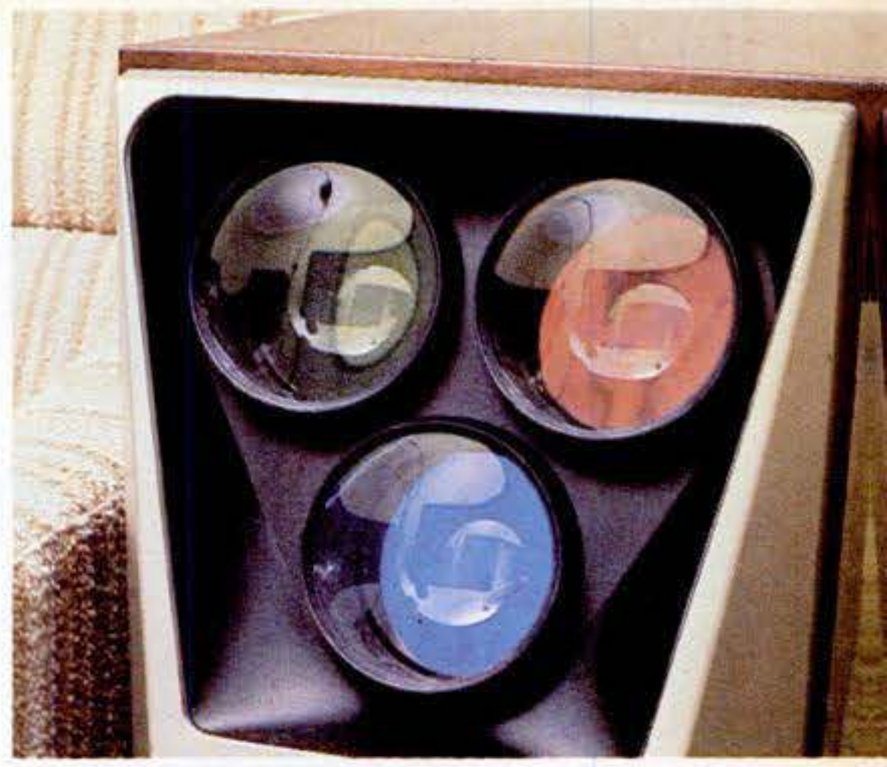
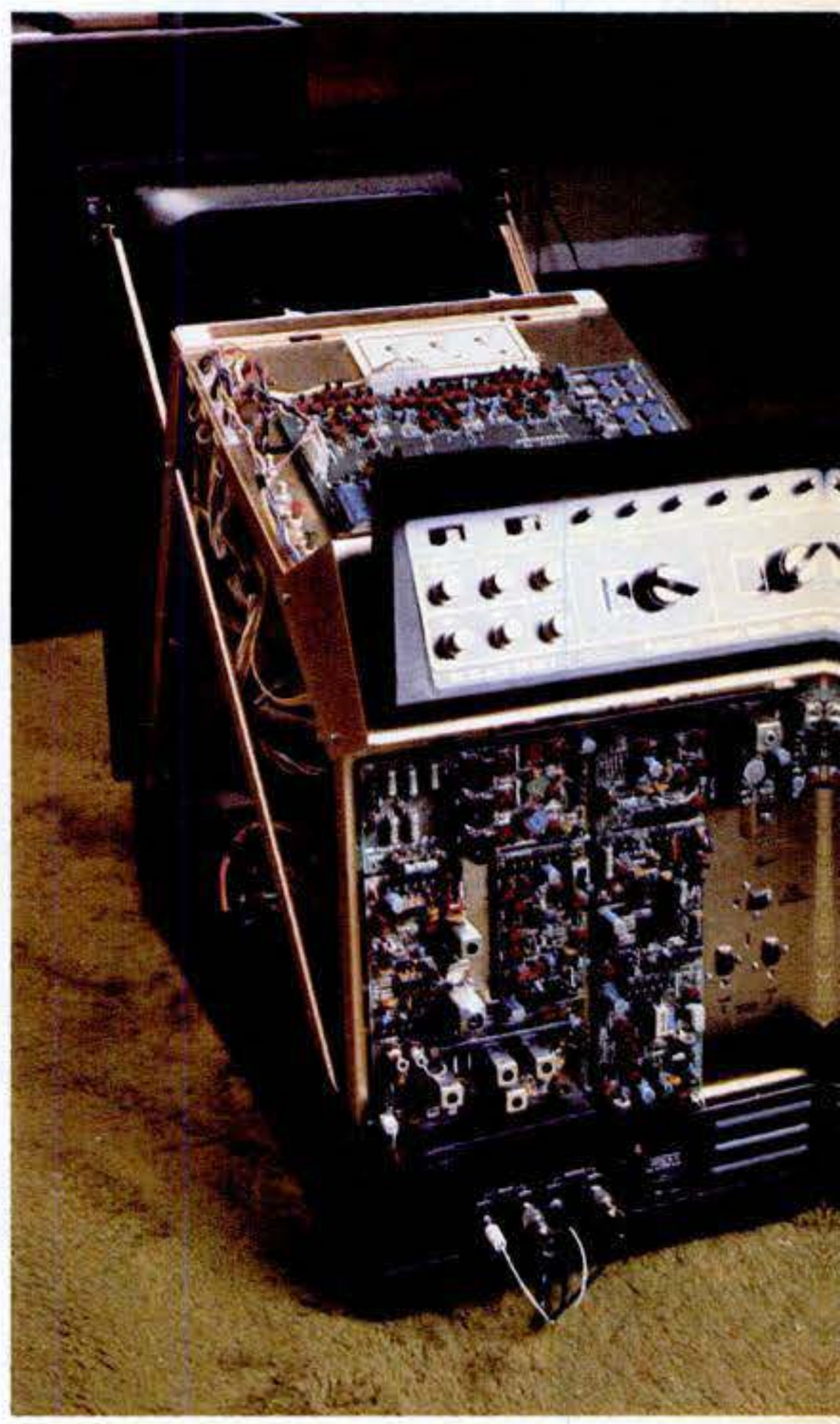
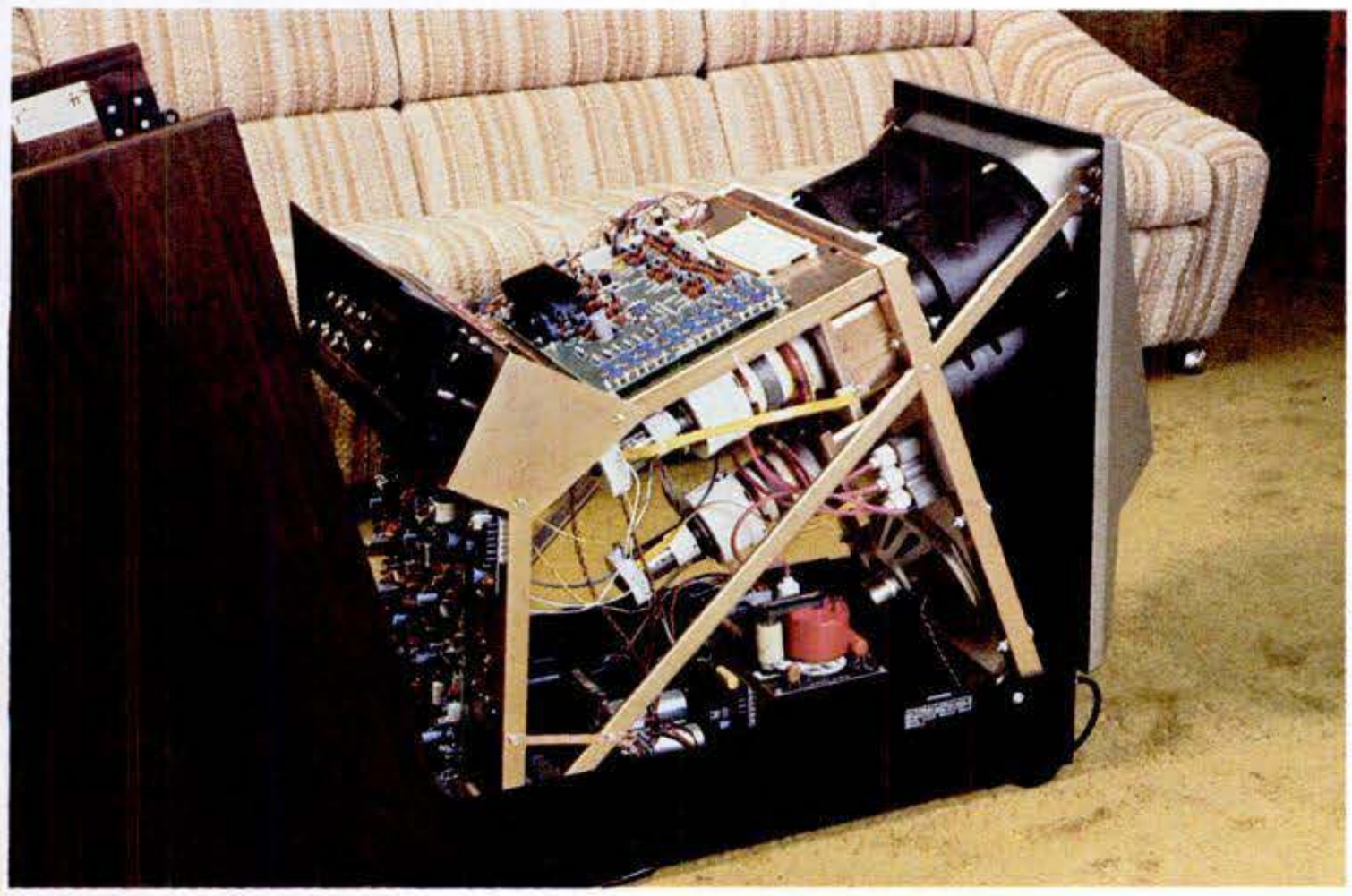
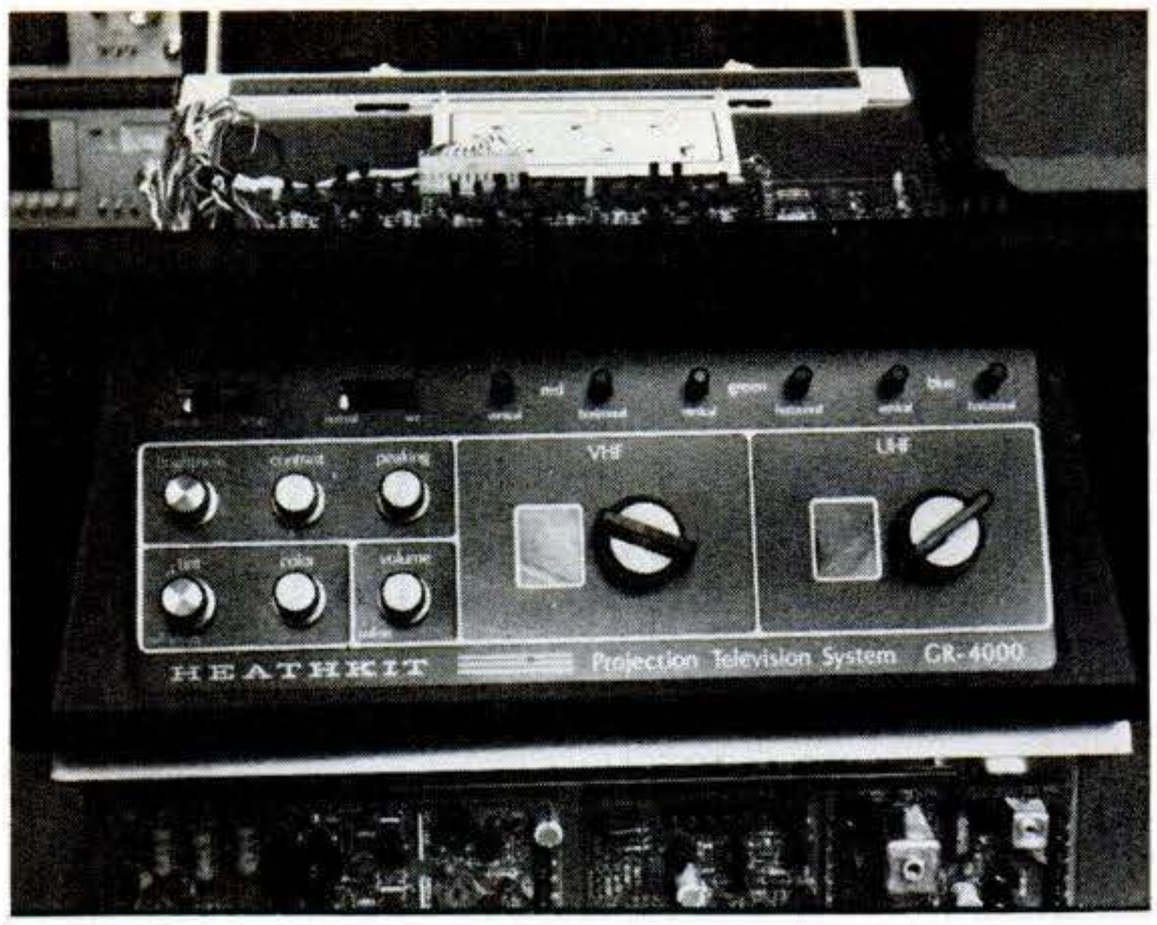


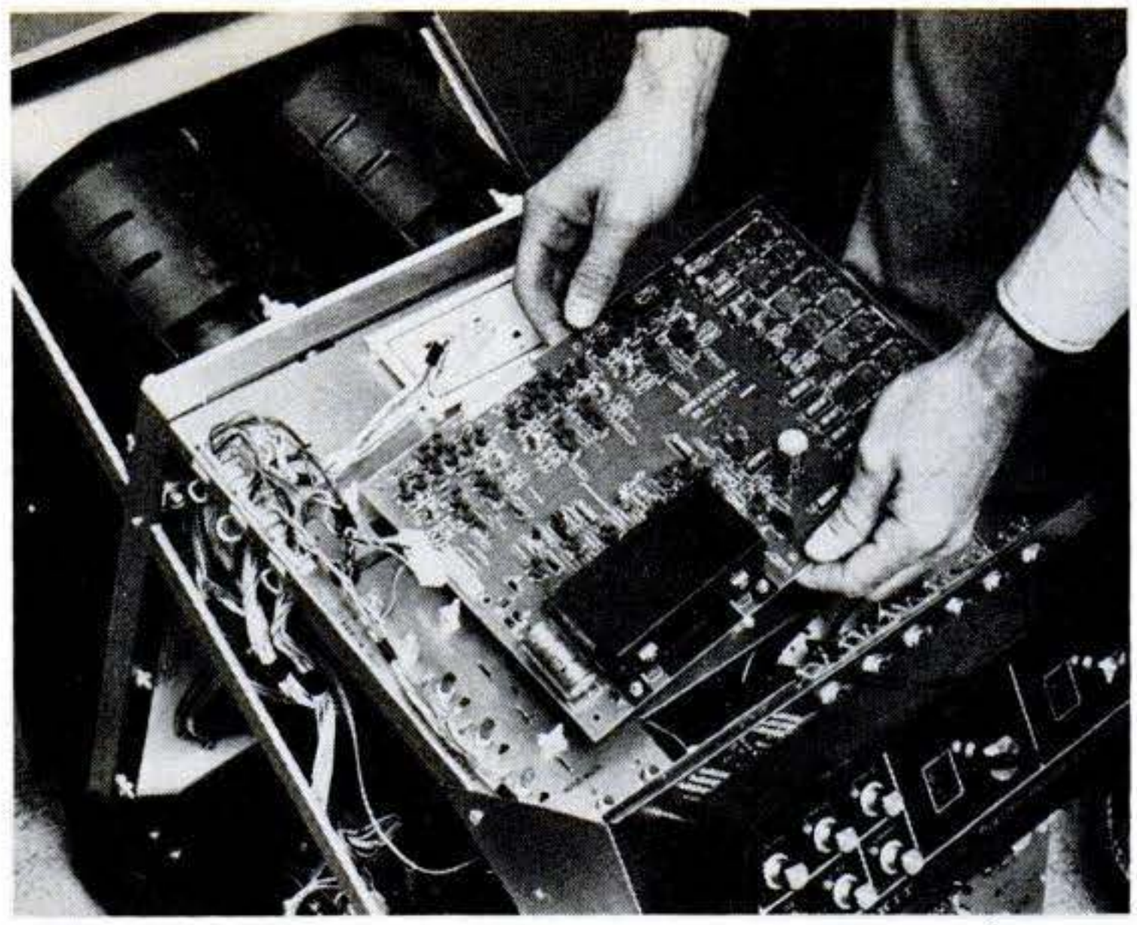




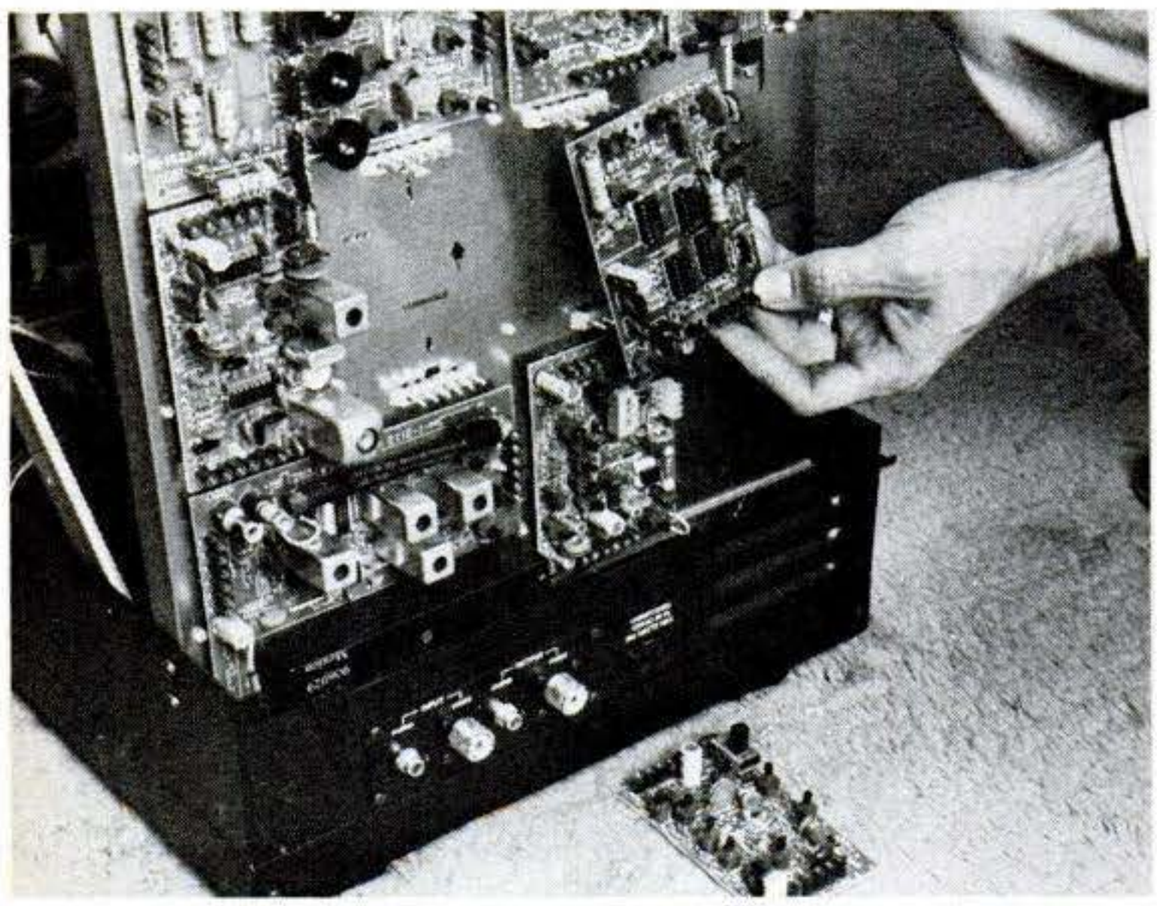
Sharp, colorful, evenly bright, six-foot-diagonal picture makes TV watching a new experience. The 45-by-60-inch screen hangs on the wall, supported by steel brackets. The image is projected onto the screen by three separate projector tubes—for red, blue, and green colors—from about seven feet away. Connectors, at the rear of the projector, allow you to use a VCR with the system at the flip of a switch. The walnut cabinet flips back and off to expose circuitry. The top and back chassis are hinged for additional access to the bottom of the projector containing the high-voltage power supply. The projector is on casters, so it may be rolled out of the way when not in use. But because of its size (16 by 32 by 28 inches), the author chose to make it permanent and rearranged his furniture around it.



Control panel is standard except for top row: VCR switch lets you play tapes (composite video) through the system; the crosshatch and setup controls allow convergence "touch up."



Convergence board mounts on top chassis. Each control sets position of color images on screen. Each time you go through the procedure, the picture becomes sharper.



Main chassis is wired from the rear and supports most of the circuit boards. Each board merely plugs in after assembly and resistance tests. Board alignment time: about an hour.

Connectors eliminate wiring across the floor. The projector covers plate when in use; rug flap folds back, covering plate when not in use. Separate AC connector must meet local codes.

screen is as important to the picture quality as soldering the right wires. The screen acts like a mirror, so it must be placed where lighting and sunlit windows don't get into the viewing angle. Normally, it hangs on a wall. An optional stand is available ($80); however, that would take up more floor space.

The screen is angled for maximum return light to a seated audience (better than 25 footlamberts of light returned to the rear of the projector) within a cone of about 15 degrees left and right of the center line. In other words, the closer you sit to the projector, the brighter the picture you see. And the farther behind the projector you are, the greater the viewing area. So, if possible, select a room and wall with the greatest depth to install the system.

The brightness level of the screen is high enough so you can watch TV in a well-lit room. Once you get down to serious viewing, however, you'll find yourself switching off the lights. I installed dimmers on all the room lights, and I bring them down a good 75 percent of full brightness. I find this much easier on the eyes than the strong contrast I got when trying to watch the screen in a totally dark room.

The aluminized screen is covered with a plastic surface (unlike other earlier screens), so it's easy to clean, won't oxidize, and you can breathe a little easier with kids that like to touch everything.

Besides picture quality, Heath has concentrated on the projector's audio as well. A six-by-nine-inch oval speaker, driven by a five-watt amplifier, is mounted just below the lenses and also faces the screen. Result: Good audio response and sound that seems to be coming from the screen itself. The projector also has a hi-fi audio output jack. If you have your hi-fi in the same room as the projector, you can couple the two for excellent sound reproduction.

New viewing habits

When you add together the giant-screen picture, high-fidelity sound, and the general "movie house" feeling you get with this kit, you come out with something much more than just a TV set. It has affected my family's entire viewing habits. No, routine shows don't get any better, so we don't watch any more TV than usual. But we now plan our evenings if a good movie or special event is on (the Olympics, for example, were great). We also plan our evenings at the theater, thanks to Wometco over-the-air pay TV and our VCR. The GR 4000 has become our home-entertainment center, not just our home TV.

For more information, write to Heath Co., Benton Harbor, Mich. 49022. PS

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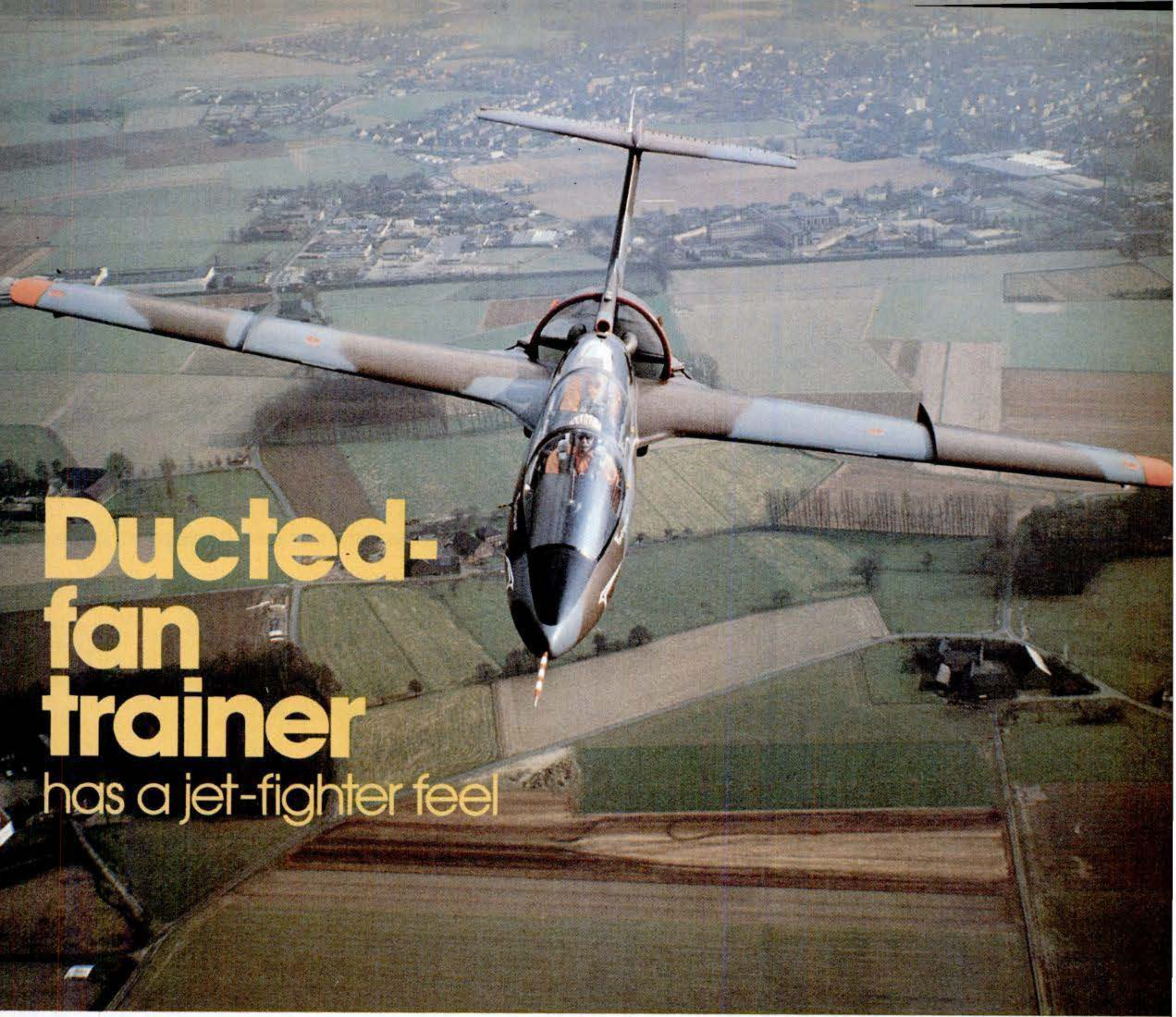

Ducted-fan trainer has a jet-fighter feel

Novel propulsion design boosts prop power

By BEN KOCIVAR

The fuel crunch has hit not only private pilots and commercial airlines, but the military, too. One problem for air-force planners: how to train pilots for high-performance jets while using as little fuel as possible.

The answer may be found in a new German plane that uses an ingenious ducted-fan design to yield the vibration-free handling of a pure jet, but at substantially lower cost. The Fantrainer, made by Rhein-Flugzeugbau of München Gladbach, Germany, will cost about $500,000 and would provide training for fighters, transports, and bombers costing $7–$30 million. And, claims the maker, it would consume only one-tenth as much fuel as the training plane the U.S. Air Force now uses.

According to Hanno Fischer, design engineer for RFB: "The saving in training only three pilots will cover the purchase cost of one Fantrainer."

The tandem two-seater has many similarities to RFB's private plane, the Fanliner, that I flew several years ago [PS, March '77]. But production problems with the twin 150-hp Wankel engines prompted a shift to an American 420-hp Allison turbine. Future plans envision upping power further with a 1000-hp engine.

Key features of the Fantrainer:

- A ring-shaped duct that fits closely around a seven-blade fan directly behind the cockpit and wings.
- Slightly swept-forward wings of glass-fiber structure and skin.
- A metal keel structure to prevent serious damage in case of a wheels-up landing.
- Interchangeability of elements, including wings and cockpit, to reproduce the characteristics of a variety of more advanced aircraft.

Secret of the increased performance is the ducted fan, whose blades reach within a fraction of an inch of the shroud. This minimizes blade-tip-vortex losses and provides about 36 percent increased thrust compared with the same-diameter conventional propeller. Another way to state it is that this ducted propulsion system can be 60 percent smaller than an open propeller would be for the same thrust.

Further improved aerodynamics comes from a movable leading-edge ring that moves back and forth at different speeds and acts to improve airflow much like the movable leading-edge slats on an airplane wing. This cuts the air drag and weight of conventional ducts, which are as long as they are in diameter and are thick at the leading edge.

The German Luftwaffe will incorporate the Fantrainer into its basic jet-training course, and the U.S. Air Force is also considering using the low-cost trainer. PS

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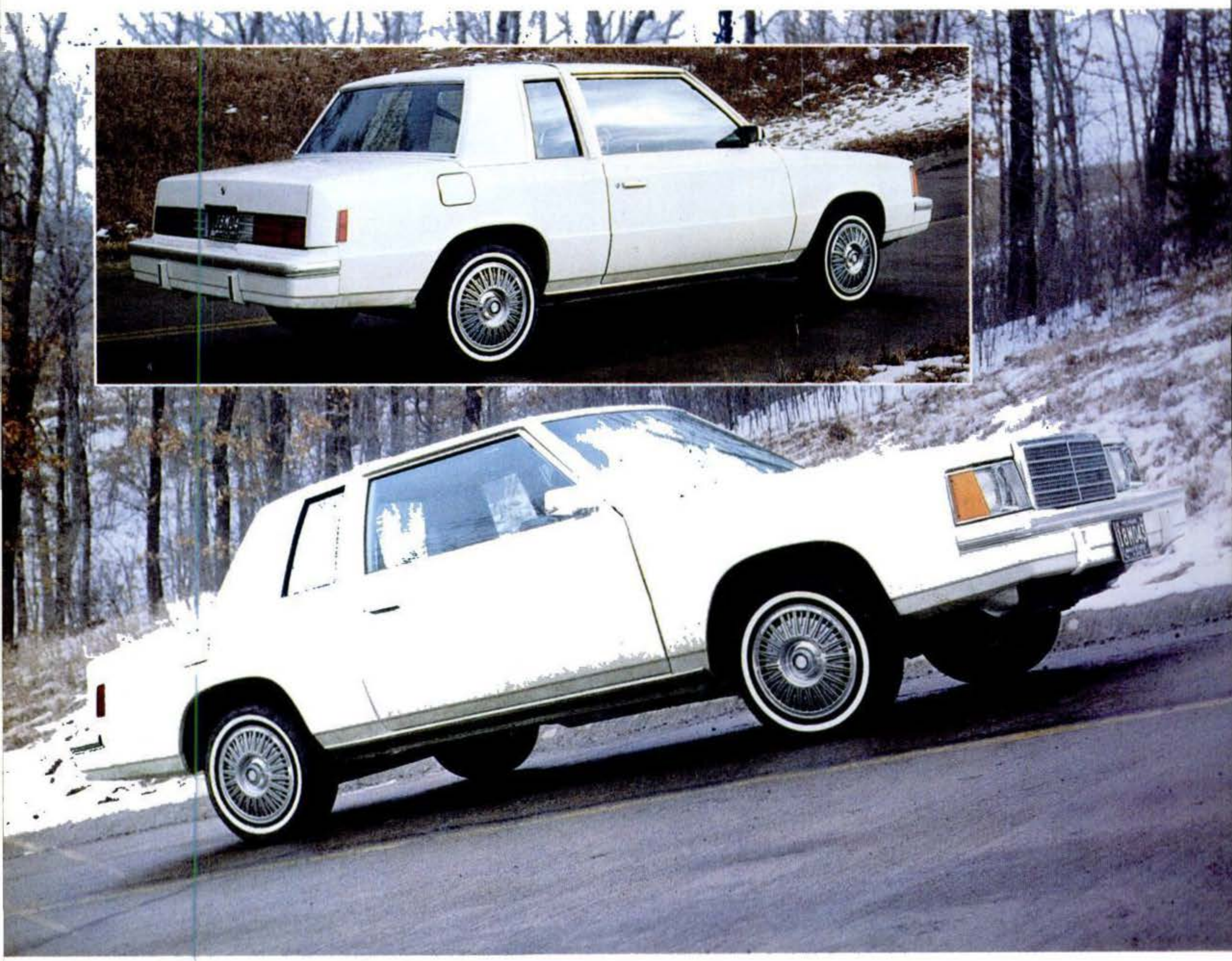
PS previews the '81 cars



K-body model was Chrysler's most persuasive argument for government loans. The Plymouth Reliant shown here is a twin to the Dodge Aries, and comes in two-door, four-door, and station-wagon types. They replace Volare/Aspen and are smaller and lighter, with a new four-cylinder engine and front-wheel drive. Look for Chrysler to slug it out for compact-car dominance, with this car matched against GM's X-bodies. Similarities between the two makes are striking, and though technically they appear equal, the fresh appearance of the K-bodies could give Chrysler a solid piece of the market.

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Detroit's new models will be more fuel-stingy as engines and vehicles shrink

By JIM DUNNE

Look out, imports! Detroit is ready to put high-mpg cars on the road in massive numbers. U.S. auto makers have an impressive fleet of 1981 models on the way, designed to slow the growth of imports and appeal to the fuel-conscious buyer.

The cars aimed most directly at the high-mileage imports are the subcompact Ford Escort/Mercury Lynx, Chrysler's slightly bigger Plymouth and Dodge K-models, and Chevrolet's new diesel Chevette. These models will be unveiled during the traditional new-car introduction period. In May 1981, GM will introduce its new J-car line, successors to the Pontiac Sunbird and Chevrolet Monza.

Detroit will bring out at least four new four-cylinder engines for 1981 and make a number of important technical improvements in carry-over models. Here's what to look for from the Big Four:

- Ford: Escort/Lynx will get 30–40-mpg fuel economy in city/highway driving using new four-cylinder engines.
- Chrysler: Reliant/Aries, key to Chrysler's future, will compete with GM's X-cars and also have a new four-cylinder engine.
- GM: Low-price, personal-luxury coupes will get new skins and look longer and sleeker. A new four-cylinder engine will power the J-cars. Chevette will get a Japanese-made four-cylinder diesel.
- AMC: The Eaglet, built off the AMC Spirit chassis, will join the Eagle in the four-wheel-drive sedan lineup.

Ford's Escort/Lynx

This car answers the booming demand for a low-price, highly fuel-efficient basic car. Four body styles are planned: two-door hatchback, two-door sport coupe, four-door sedan, and four-door station wagon. The introduction will be strung out over six months, with the hatchback and station wagon ready first.

With 1.3- and 1.6-liter engines, smaller than the 2.3-liter four in the Pinto and lighter by around 475 pounds, the new cars will be competitive with imported economy cars.

Escort/Lynx features include a transverse engine, front drive, and hatchback rear opening.

The engines are all new. They feature an aluminum head with cast-iron block. The different displacements result from slightly different lengths of piston stroke. The combustion chamber is hemi-shaped.

Continued

Ford's new subcompact comes in two versions for 1981, the Ford Escort and the Mercury Lynx. It's smaller than the Pinto/Bobcat, which it replaces, and features the predictable front-wheel drive and four-cylinder engine. In addition to the two- and four-door sedans and station wagon, a sporty coupe will be offered. Highway fuel economy should top 40 mpg.

Olds Cutlass is the best-selling vehicle in its class. Along with Monte Carlo, Regal, and Grand Prix, it gets an extensive face lift, which will help keep this group among the top-selling models of all U.S.-built cars. Lines are smoother, and the cars have lower hoods—a longer look overall.

Buick features V6 engines in the Regal, including a turbocharged version, and the trend will continue in 1981. Other fuel-economy advances will be better aerodynamics in the body shape and a lock-up transmission that will improve efficiency by as much as six percent at highway speeds.

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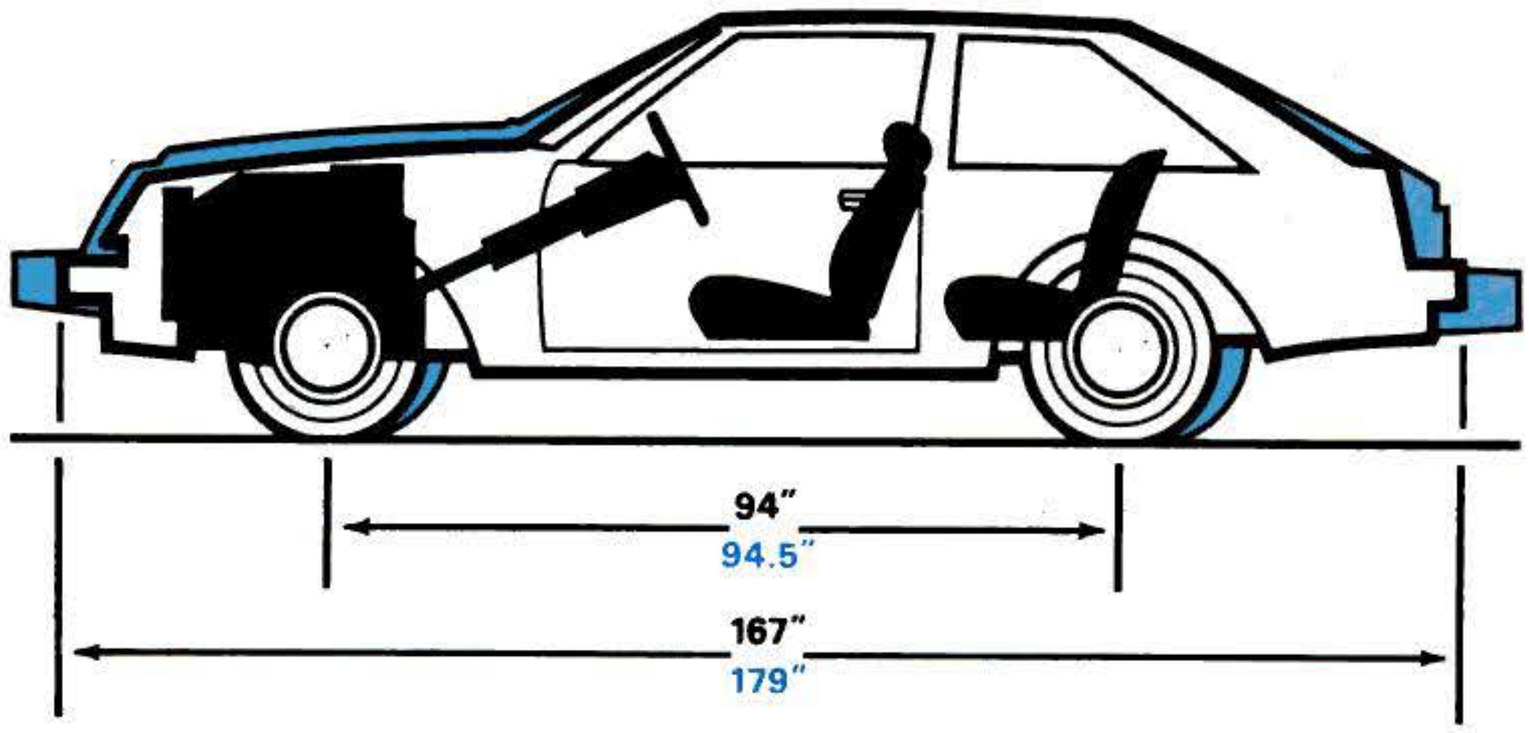
How Ford Escort compares with the Pinto



Layout of Escort contrasts sharply with that of the older Pinto (in color). Escort's front drive train leaves more room for passengers and luggage.

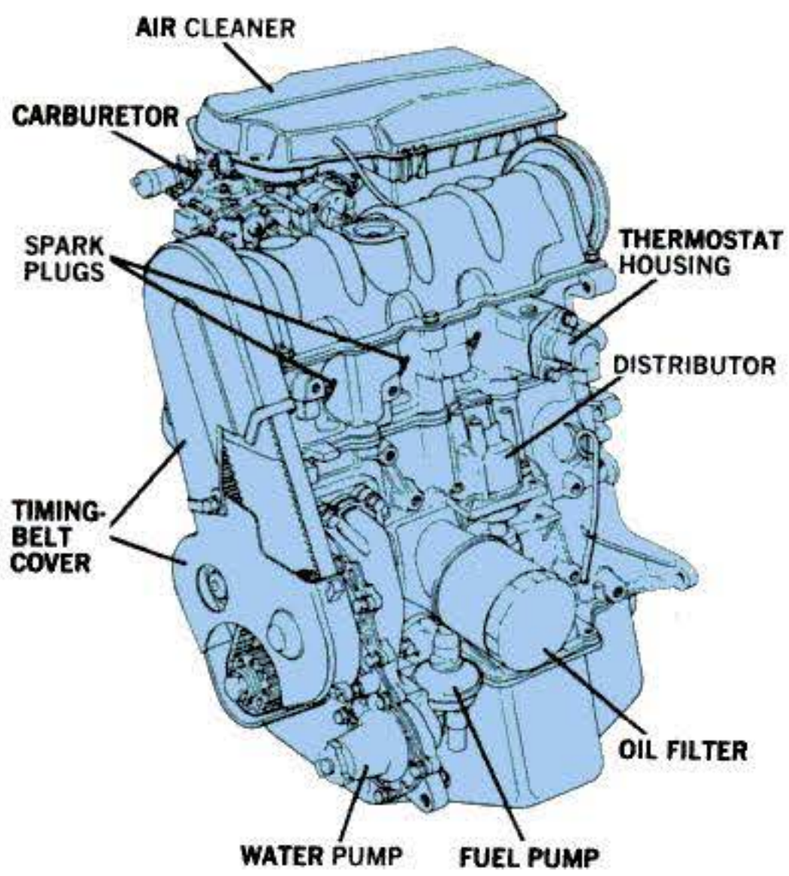
The 1.3-liter displacement is the smallest of any U.S.-made automobile engine. (The German-made Rabbit engine is 1.5 liters.) The iron block weighs a mere 68 pounds, while the complex aluminum head is about half that.

Both manual and automatic transmissions will be available. The car will nominally seat four passengers, though rear-seat room will be cramped when compared with typical U.S. compacts.

Ford's other big change will see Granada and Monarch discard their present body style and take on a modified Fairmont body and chassis. The change means that Granada/Monarch will offer a station wagon for the first time. It is also a prelude to a major change in the Fairmont in 1982. Overall styling of Granada/Monarch will continue the theme of a more expensive car than Fairmont/Zephyr.

Chrysler's K-body cars

If the Plymouth Reliant and Dodge Aries become as popular as GM's X-cars, the financially plagued company will have a bonanza in 1981. The K-body is close to the X-body in size, concept, and fuel economy. Front-wheel drive will make for a smaller package than the Volare/Aspen on the outside, but with virtually the same passenger space inside. (For technical details, see PS, April.) The K-body will come in three styles—two- and four-door sedans and four-door wagon. The similarity in styling between the K-models and Buick's highly successful Skylark is striking. The K-body's 99.6-inch wheelbase is five inches shorter than the X-body's, but overall length is about equal. That proportion makes for a longer hood and deck line, but more upright overall styling.



Four-cylinder engine for Chrysler K-body cars has a 2.2-liter displacement. It has an iron block and aluminum head with an overhead camshaft.

A new 2.2-liter, four-cylinder engine powers the Reliant/Aries, Chrysler's first four in more than 40 years. As an option, a 2.8-liter four built by Mitsubishi will be offered to buyers who want more performance or pulling ability. Fuel economy is expected to be in the 25–35-mpg range for city/highway driving.

A revamped Imperial will be the new flagship of the Chrysler lineup. It's a luxury coupe, built on the same 112.7-inch wheelbase as the Cordoba. Chrysler board chairman Lee A. Iacocca took special interest in the Imperial project over a year ago and is determined to make it one of the most appealing of the small group of high-price, personal-luxury cars.

"We think buyers want comfort and good gas mileage, but they also want to have something pretty luxurious. We think we've got that kind of a car," says Iacocca. Extra features might include pickup and delivery when maintenance or repairs are needed, with a substitute car furnished while the Imperial is in the shop.

The GM campaign

Buyer tastes change quickly, and sometimes even GM gets caught leaning the wrong way in making styling changes. That's the situation with the 1981 personal luxury cars: Monte Carlo, Grand Prix, Cutlass Supreme, and Regal. Two years ago, when these models were introduced in a smaller size, GM brass felt that they looked too small. Plans for making them look bigger were quickly put into effect. So the 1981 models will look longer, wider, and heavier, thanks mainly to a rounding of sheet-metal surfaces, though the actual differences will be fractional. In the meantime, buyers are turned on to smaller cars, so that now the bigger look may be counterproductive.

A major engineering change at GM is the new four-speed overdrive automatic transmission that will be offered in the 200 size; it fits most small V8's and all rear-drive cars equipped with six-cylinder engines. The new transmission is similar to Ford's AOD and will improve highway fuel economy by three mpg or more in most cars.

Chevrolet's Chevette will get an Isuzu 1.8-liter four-cylinder diesel option for '81 sometime after production startup. It should make the subcompact one of the highest-mpg cars sold in the U.S.

GM's biggest blast will come at mid-model year when the replacements for the Monza and Sunbird go on sale. Styling of these sporty subcompacts leans strongly to the BMW line, but these two will match the fuel economy of the Chevette. Front drive will be a top feature, so look for lots of borrowing from the X-car lines for functional parts. Four models are planned: two- and four-door notchbacks, three-door sport coupe, and four-door wagon.

We see a lot of changes toward more fuel-efficient cars, but it is still startling to note that Cadillac will have a six-cylinder engine in the 1981 de Ville line. It's the first Cadillac six in history, and the same 4.1-liter, 252-cu.-in. V6 that Buick uses in the Electra. With the switch, Cadillac will improve city fuel economy by two mpg, and, with the overdrive transmission, highway economy even more.

AMC's Eaglet

In the midst of a switch to foreign car production, AMC will have minimal changes in its remaining two sedan lines, Spirit and Concord. A Spirit version of the four-wheel-drive Eagle—tentatively called Eaglet—is ready for 1981, but, essentially, the company will go with what it had in 1980. An interesting possibility is a hookup of the 151-cu.-in., four-cylinder engine in the Eaglet, which would give that car fuel-economy efficiency that the Eagle can't touch. PS

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PS tests two new outboard steerers

By BOB STEARNS

Cruising along in peaceful Biscayne Bay I swung the wheel hard to port, putting my 18-ft. center console into a tight turn. This would be a good trial for the new hydraulic outboard steerer I was testing. Coming out of the turn, I braced myself for the usual wheel fight needed to wrestle the 75-hp. engine back on a straight course. But there was no fight. The wheel responded smoothly to my touch, without any engine-caused torque.

Effortless steering is characteristic of the new SyTen hydraulic outboard steering system from Teleflex Inc. (155 S. Limerick Rd., Limerick, Pa. 19468). Steering is also easy with another system I tested—OMC's new auxiliary outboard steerer.

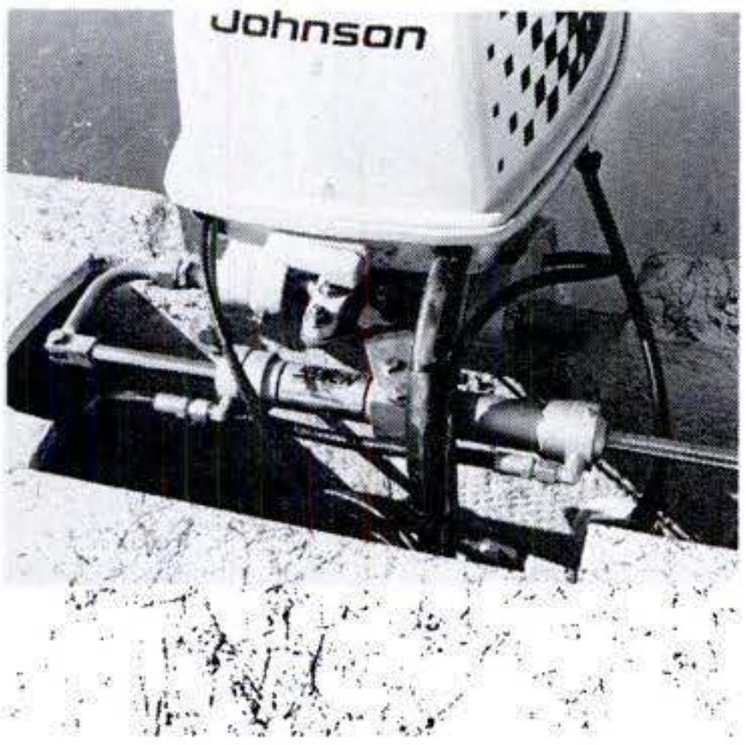
Even with hands off, the SyTen-steered boat stays on course in a tight turn. The hydraulic system's push-push steering kept engine/prop torque from turning the steering wheel. Regardless of the boat's speed or heading, the author found, the engine wouldn't alter course even slightly without wheel guidance.

Effective arrangement

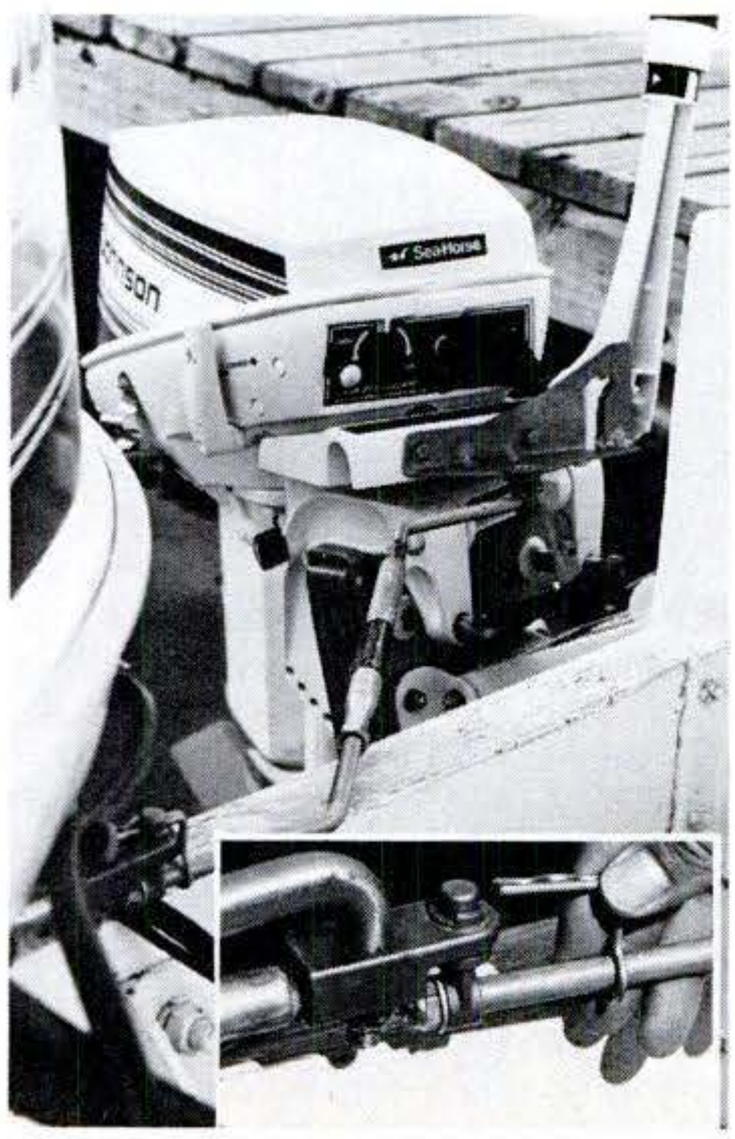
In my opinion, the compact, well-engineered design of the SyTen system makes it a significant step forward in hydraulic outboard steering. Unlike systems I've tried in the past, the SyTen has no bulky external fluid reservoir. The one quart of hydraulic fluid needed to operate the system is entirely contained within its three components: the helm-mounted pump housing, the steering cylinder, and the connecting hoses.

The SyTen steers with a "push-push" action, instead of the "push-pull" steering method used by mechanical steering systems. The helm unit contains six miniature pumps. Turn the wheel, and the pumps force hydraulic fluid into either the right or left connecting hose, thus pushing fluid into the proper end of the transom-mounted steering cylinder.

[Continued on page 154]



Compact hydraulic system, shown above installed in PS test boat, requires no more room on the transom than most mechanical systems. The entire cylinder assembly mounts out of the way, just behind the electric shift and throttle cables. Installation requires only basic tools, and can be done by most do-it-yourselfers.



Snapped into a retaining clip bolted to the small motor, OMC's auxiliary steerer stows smartly out of the way when not needed. Installing the OMC steerer kit takes under an hour.

Quick-release adapter (inset, left) links OMC's auxiliary steerer to the bigger engine's control cable. The tie bar connects to the auxiliary motor by means of a bracket bolted into existing holes. Roughly wedge-shape on its upper right side, the bracket braces the tiller in place, preventing it from flopping over and getting jammed against the transom.

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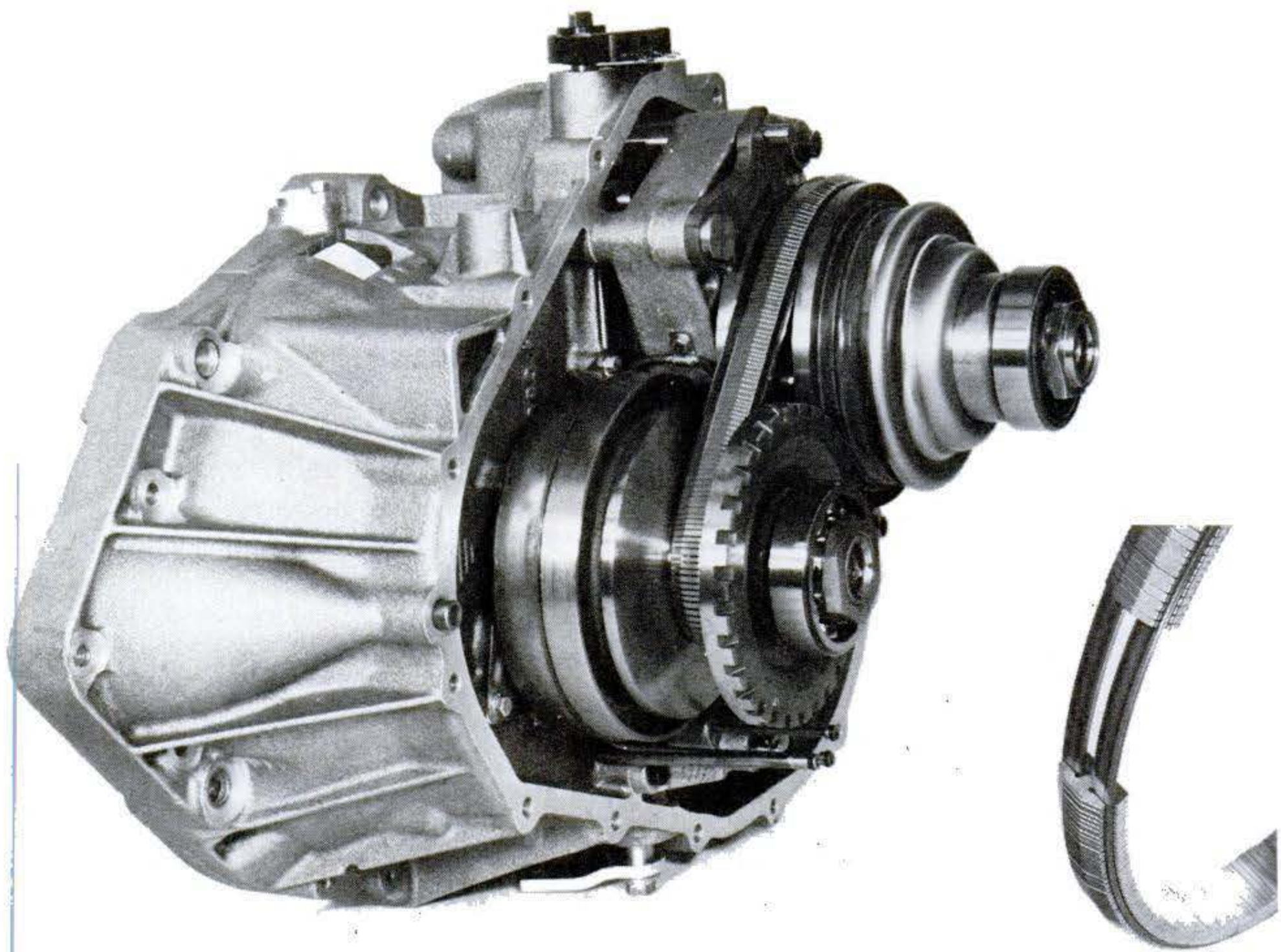
CVT
— the no-shift transmission



A "beaded" belt moves on pulleys for continuously variable transmission

By DAVID SCOTT

TILBURG, HOLLAND

"Just push on the accelerator," said Seian van der Veen from the passenger seat. "You'll feel the difference." I eased the pedal down, the engine note rose above its idle purr, and the car rolled off smoothly. Everything normal. But as I pressed harder, accelerating to 30 mph, I sensed two oddities: The tachometer showed engine speed stayed at around 3000 rpm, and there were no transmission shifts.

The front-drive Fiat Strada I was driving in Tilburg has a CVT (continuously variable transmission) that could be a real breakthrough in fuel economy, compactness, and manufacturing cost. It has no gears. This is a belt-drive Transmatic developed in Holland by van Doorne's Transmissie, where van der Veen is the project chief.

"With no gears to change," he explained, "it gives a wide and stepless ratio spread. That enables the engine to run at almost constant revs near its point of maximum efficiency, regardless of load or the driver's power demand. Gas consumption is thus lower

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and there is no power-robbing torque converter."

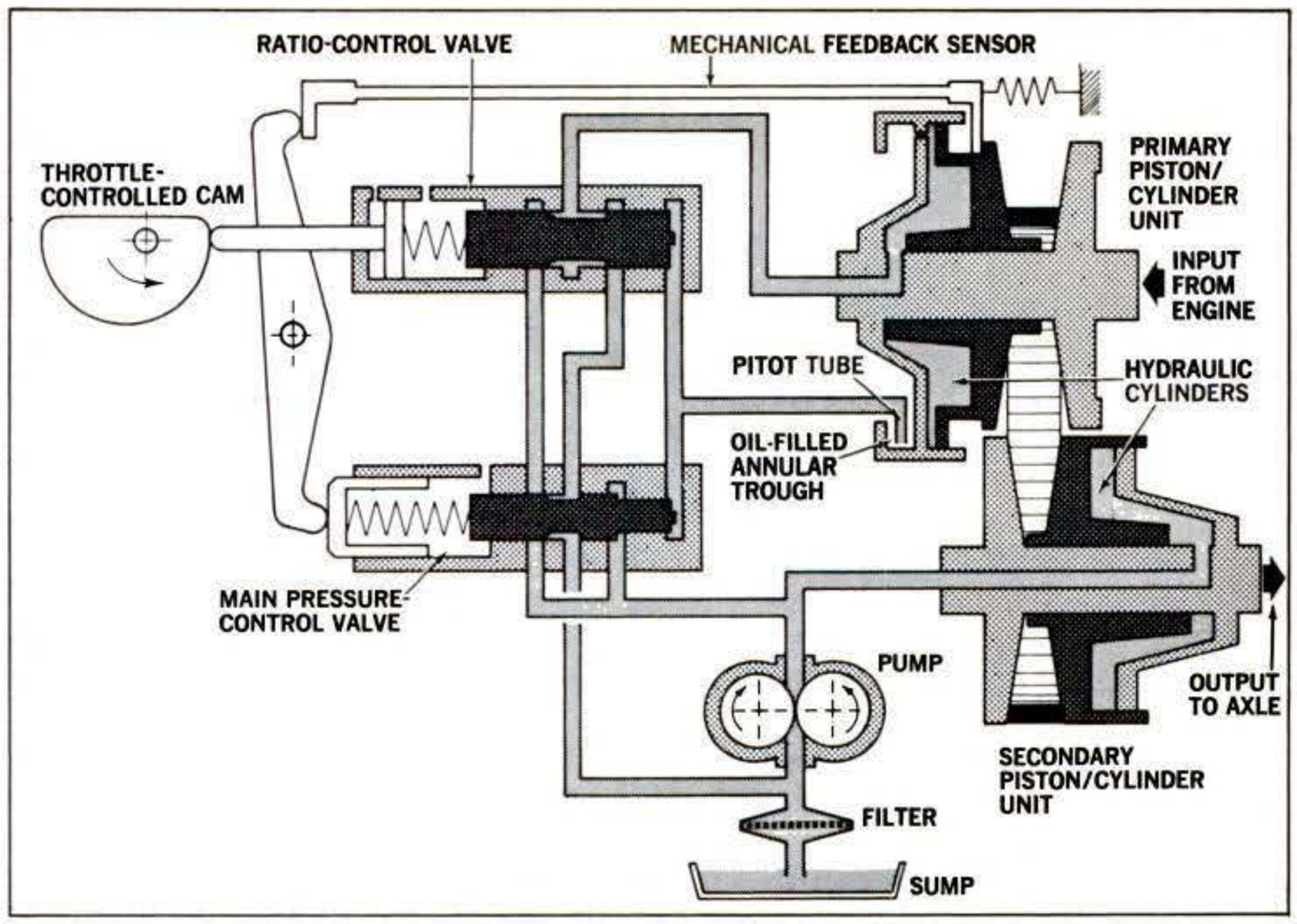
The working principle is not new. Belt transmissions have been used for industrial drives for years. "But they have limitations in torque capacity, efficiency, and overall performance," van der Veen explained. The answer was a steel belt, and a most unusual concept.

Belt drives normally rely on tension to transmit energy between pulleys. This one doesn't pull, it pushes, for greater no-slip torque capacity.

In its basic form, the belt is an endless string of thin, wedge-shaped blocks running loosely on a laminated steel loop, like beads on a necklace. But the blocks—not the loop—transmit the engine torque. They're held in a rigid stack by the loop, and push each other along to transmit power. The loop is laminated from 10 concentric bands of steel, each a mere 0.2 mm thick. This way-out belt design combines strength with flexibility, like multistrand wire cable. Total thickness of the pack is about two mm. When traveling between the pulleys, the loop moves slightly slower than the train of blocks. Moreover, the individual bands themselves circulate at slightly different speeds.

The ratio is altered by hydraulically widening one pulley and simultaneously narrowing the other to match the fixed belt length (see drawing). With stepless changes, the ratio is now 4:1, wider than most manual gearboxes. This will be increased to 5:1 on production transmissions for greater economy benefits. There are no gears other than one epicyclic set for reverse. A simple hydraulic control box has only two valves.

Durability? "Many of the 100 test cars with prototype transmissions have covered 100,000 miles without any failures," van der Veen told me.



Ratio changes by varying pulley diameters. Sliding pulley cones act as a piston in a hydraulic cylinder. Cylinder pressure depends on: ratio in operation, sensed by feeler on primary pulley cone; engine speed, detected by pitot tube immersed in rotating oil-filled trough; throttle, determined by cam on accelerator shaft. At rest, primary pulley contracts as shown for minimum diameter—secondary pulley is fully expanded. When engine-driven pump starts, oil feeds to secondary pulley cylinder, clamping belt to torque level determined by main valve. As speed increases, ratio-control valve eases open primary pulley, secondary pulley closes. Belt position on each pulley changes—changing the ratio between them.

Belt being held was used in Fiat Strada. Beaded construction allows it to fit pulley radius as small as 30.5 mm. Larger rear belt is for medium-weight trucks.

Back on the road

I stamped on the throttle pedal. The engine revs momentarily shot up to 4800 rpm, then dropped to 4500. In the same instant, the car bounded ahead as the Transmatic *slid* into a lower ratio. There was not a hint of kickdown jerk.

At 60 mph I eased up on the pedal and the revs smoothly fell to 3500. The pulleys were slowly shifting back to "high." With no forward gears, the transmission is completely silent.

"Now try the engine braking," van der Veen said. I lifted my foot, flipped the gear lever to one side, and the car slowed rapidly to the tune of a revved-up engine. The down-change was gentle and noiseless.

Low losses in the Transmatic contribute to the fuel-saving benefits. "Consumption now is the same as with a five-speed manual box," said a smiling van der Veen, "and up to 20 percent better than existing automatics. And widening the ratio span to 5:1 with larger pulleys will better that."

The Transmatic has some strong backers, and may be in car showrooms around the world in two years. Borg-Warner linked up with the Dutch company in 1978, and will help build and assemble these revolutionary automatics in its British factories. The first production versions could be ready for the '82 model year.

Fiat is a third partner in the new group, and has contributed development know-how from experience with its own similar CVT's. It is expected to be the first major user of the transmission. The 100 prototypes van der Veen has installed have gone into models from Ford and Renault—also likely customers—as well as Fiats. PS

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Now they're running on propane or gasoline in **dual-fuel motor homes**

Cheaper LP fuel helps beat the skyrocketing cost of gasoline for RV owners

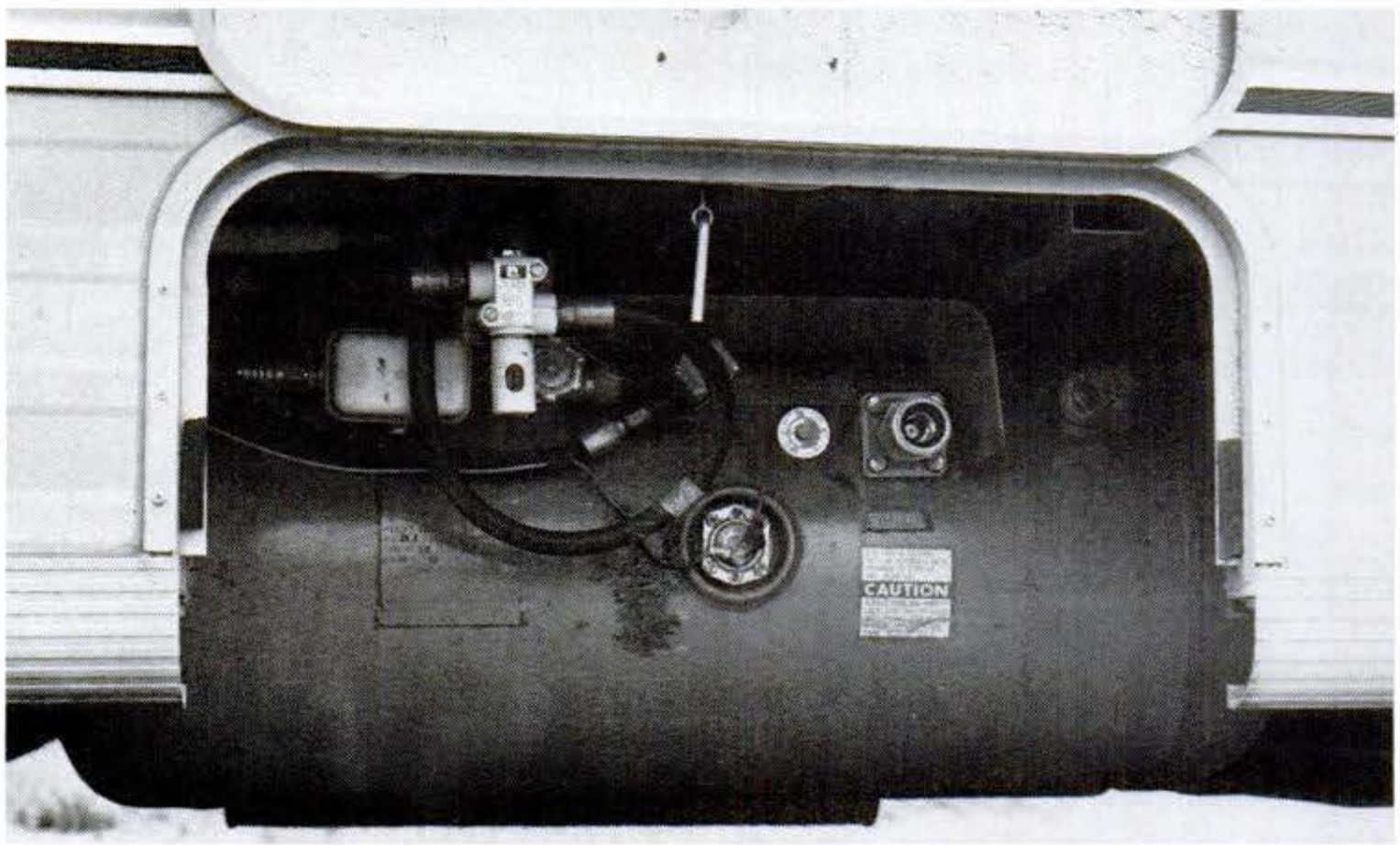
By HERBERT SHULDINER
PHOTOGRAPHS BY GREG SHARKO

I was cruising along a Long Island, N.Y., highway in a new Midas 26-foot motor home when I leaned over and flipped a switch to shut off the gasoline supply. In a moment, the engine began to sputter, so I flipped the switch to feed fuel to the engine again—but now it was running on propane instead of gasoline. What's more, the fuel cost dropped significantly, because propane is cheaper than gasoline—as much as 35 to 40 percent less in some parts of the country.

The Midas motor home is one of a growing fleet of recreational vehicles that now have dual-fuel capability. RV makers are rushing to equip some of their big motor homes with special hardware that gives drivers the option of running with the cheaper propane when it's available, or on standard gasoline when it's not.

I recently had an opportunity to test the dual-fuel Midas and a similarly equipped Winnebago 26-foot Chieftain motor home. I wanted to check out the convenience, economy, and performance of this type of RV. With Associate Automotive Editor Ed Jacobs driving, we ran acceleration and noise tests on both gasoline and propane modes. I also did some general highway cruising running on both fuels. Here's what we found out.

It's surprisingly easy to use the dual-fuel systems. A simple dashboard toggle switch or knob controls fuel selection. You merely turn the knob or flip the switch, wait until the engine sputters (signifying that residual fuel has been burned), then switch to the second fuel. You can do it while cruising or standing still. The Midas' switching system seemed easier to use, but Winnebago's wasn't really difficult.



Same propane tank fuels engine, furnace, water heater, range, and oven in motor homes. Winnebago's 20-gallon tank is shown here; an optional 35-gallon tank is available. The Midas we tested had a 42-gallon tank. A bigger tank suits motorhome-engine fuel needs, especially if you're using lots of propane for heating and cooking. Remember that propane gives poorer fuel economy than gasoline.

My major impression is that there's no visual or audible difference whether driving on gasoline or on propane. The engine sounds the same. And sound-level meter readings failed to reveal any significant noise differences. There are no noticeable differences in odor (except for one instance when we got a whiff of propane while switching modes in the Winnebago).

There were numerous backfires, however, in running the motor homes when we were switching fuels. Tom Godburn, a Midas engineer who accompanied us on the tests, says the backfires occur when gasoline isn't burned off completely while switching fuel modes. One backfire blew out the side of the Winnebago's Carter ThermoQuad carburetor. We retested the same vehicle after the carburetor was replaced and the problem didn't occur again. Winnebago says it is no longer using carbs with plastic walls. New steel carburetors should withstand any possible damage from backfire pressure, it claims. And the Midas, which had a steel carb, suffered no damage despite several backfires.

We found that propane performance was significantly slower in timed acceleration runs. The Winnebago, powered by a Dodge 440-cu.-in. V8, averaged 24.2 seconds from a standing

[Continued on page 156]

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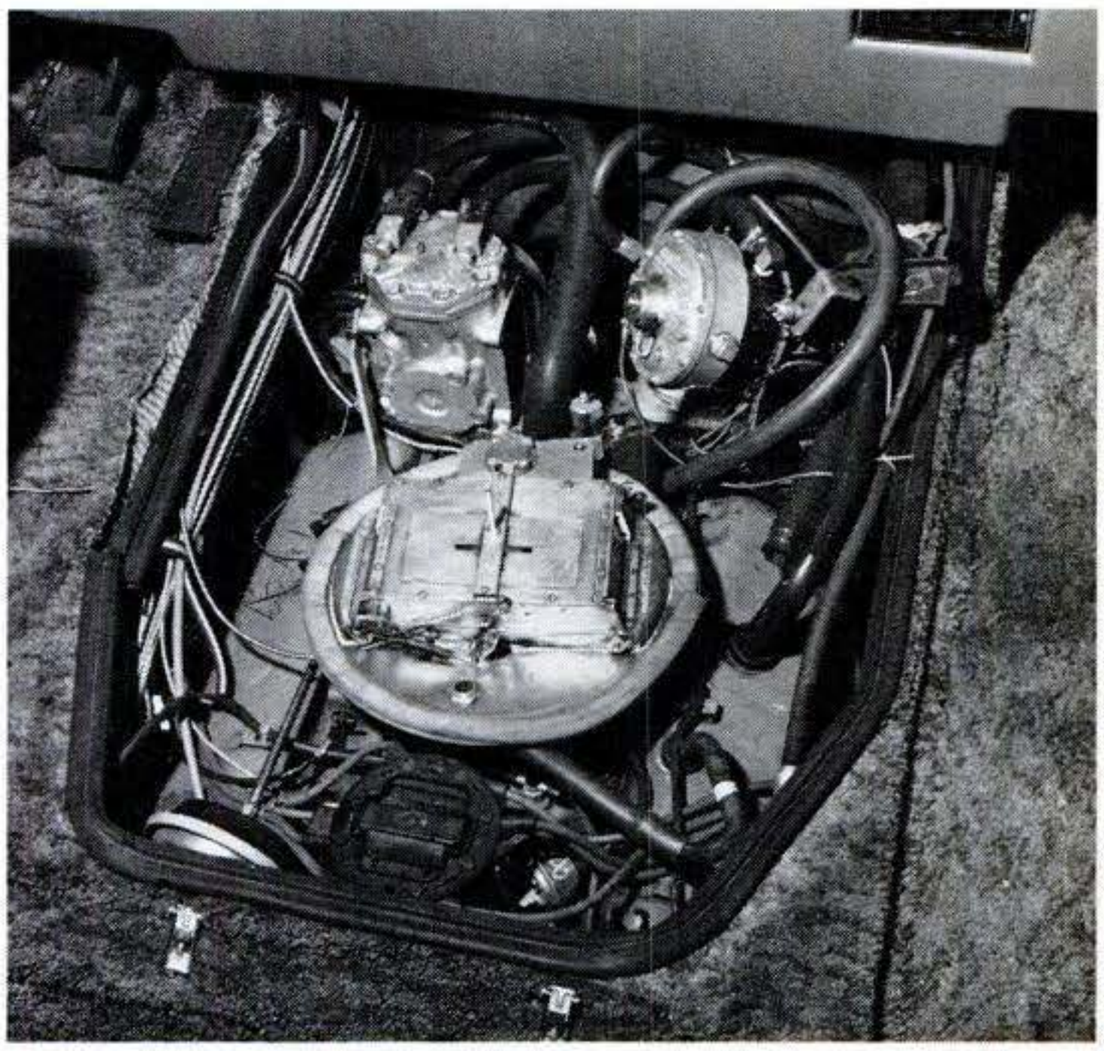
Dual-fueled motor homes from Winnebago (left) and Midas can reduce fuel costs by 30 percent if run exclusively on propane. Midas is built on a Chevrolet chassis; Winnebago is built on a Dodge platform. Both chassis makers extend the same warranty on engines that are used for propane service as they do for exclusively gasoline-fueled power plants.



Dual-fuel system in Winnebago tested by PS is made by Vialle and uses a Carter ThermoQuad carburetor. The propane mixer mounted inside the air cleaner (top) receives vaporized gas from a converter that changes liquid LP into a gas. Then the fuel is fed in a conventional way to the carburetor. Lowest knob (bottom) is fuel-mode selector. Gauge next to it gives LP level.

Midas propane/gasoline system is made by Marvel-Schebler/Tillotson Div. of Borg-Warner, and uses a Century Acu Carb. Century mixer (top) has two doors on top that provide a built-in backfire relief—a feature Winnebago's system lacks. Bottom photo shows toggle-switch fuel-mode selector in Midas. We found it easier to use than Winnebago's knob selector.

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New compact bench tools
do big jobs in small shops

Bench-top power tools are lightweight and completely self-contained. They are convenient to set up, yet small enough to store out of the way between jobs.

These versatile small tools come at reasonable prices

By A. J. HAND
PHOTOS BY THE AUTHOR

Today's homeowner is caught in a real squeeze. The cost of labor for home improvements and repairs keeps going up, while the supply of capable professionals willing to do the work when you need it done keeps going down. The logical solution is to do the work yourself. But today many of us neither can afford the stationary power tools we need to do the work nor have the space for a full-time shop to house those tools.

The result is a new trend in power tools: the birth of the compact, or "bench-top," stationary power tool. These tools are small and light enough to be stored out of the way between jobs; yet each is self-contained with its own built-in motor so you can whisk it out of storage, put it on your bench, and start working whenever necessary—all in a matter of seconds.

And though bench-top tools are a new idea, they are already made in a variety of types including table saws, band saws, drill presses, and sander/grinders.

For the past few months I've been putting samples of these tools through their paces in my shop, comparing them to one another and to the full-size tools I've become accustomed to over the years. How do they rate? As you might expect, they can't match the capacity or working speed of my full-size power tools. Still, they all do a fine job within their limits. And some of them will do things my bigger tools can't do.

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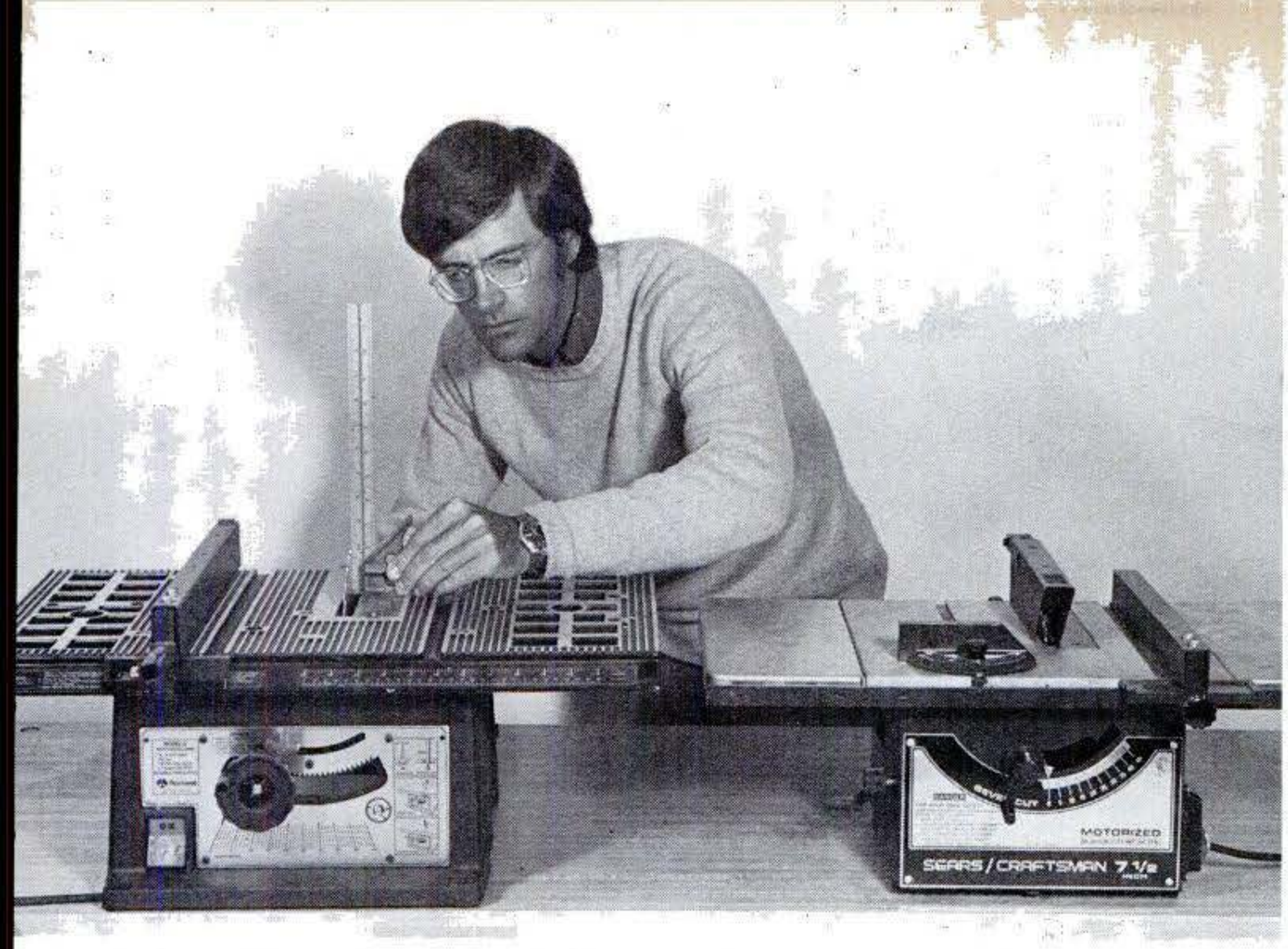

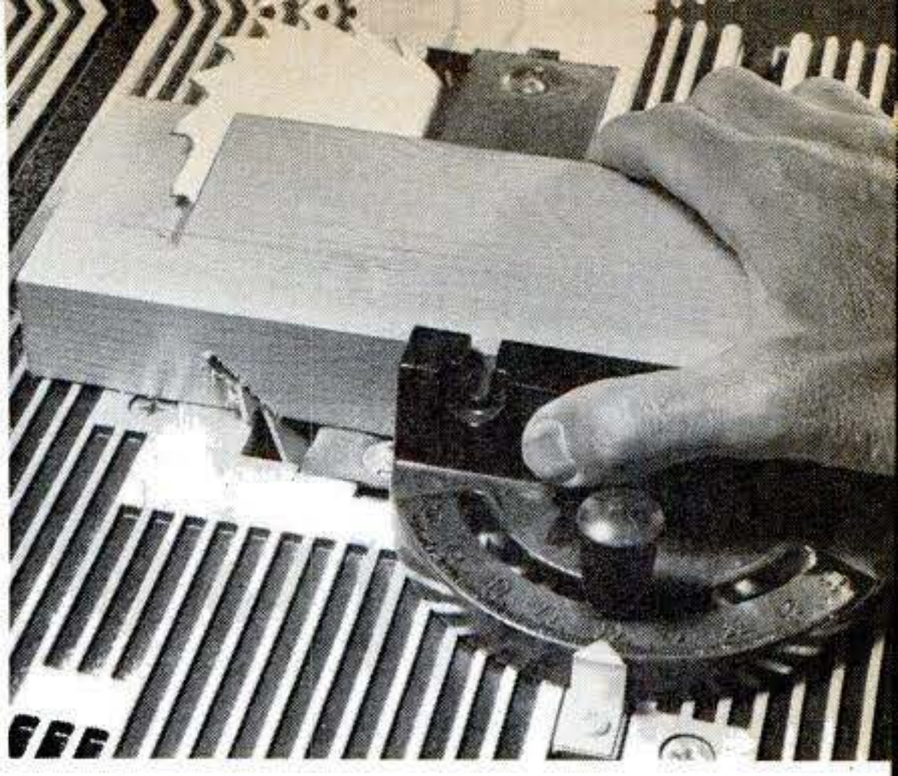

Rockwell Model 8 and Sears Craftsman 7½-in. saws (above) will both cut accurately if properly set up. They are very capable when cutting one- and two-inch nominal lumber, but can't handle full sheets of plywood unless fitted with homemade table extensions. Rockwell has a slight edge in capacity over the Craftsman, but both will cut through two-inch lumber at 45 degrees (above right). Miter gauges are second-rate, with no stops at 90 degrees and a loose fit in the table slots. Rockwell Model 8 has a unique quick-release tilt adjustment (right). Loosen the knob at the top, then slide the handwheel assembly to the desired degree marking and relock top knob. Safety switches are found on both saws, a real virtue if you have kids in the house. Rockwell switch can take a padlock; Sears switch is inoperable if a part is removed. Prices: Rockwell $165; Sears $130.

TABLE SAWS

The table saw is the basic power tool in any shop. If you buy one, you want to know it can handle any job you throw at it. These two little saws, the Rockwell Model 8 and the Sears Craftsman 7½-in. Motorized Table Saw, should fit the bill for most home use.

The Rockwell gets the nod for capacity. Its eight-inch blade can cut a maximum thickness of two inches. That's a bit over a quarter inch more than the 7½-in. Craftsman blade can handle. Still, even the Craftsman can cut through two-inch nominal lumber with its blade cranked over to 45 degrees; so both are big enough to cope with the woods and cuts commonly encountered in the home shop.

The Sears saw has an eight-amp motor that runs at 3450 rpm, while the Rockwell's motor is rated at 9.5 amps and turns over at 5300 rpm. In addition, the Rockwell is heavier and seems more substantially made. For these reasons I expected it to cut faster and more smoothly than the Craftsman.

In practice, however, both saws cut at about the same rate. And surprisingly, the Craftsman produced much smoother cuts. The Rockwell's roughness had me puzzled for a while, but I finally located the problem. The blade arbor has a certain amount of end-to-end play. This lets the blade wander slightly from side to side, while the blade on the Craftsman tracks straight and true.

There are other differences between the two saws. Both have the usual handwheels for raising, lowering, and tilting the blade. But the Rockwell has a second means of tilting the blade that is very slick. You can loosen the tilt-lock knob and then simply slide the handwheel assembly to achieve the desired tilt. This arrangement lets you vary the cutting angle from 90 to 45 degrees or back in about five seconds. That sure beats cranking a handwheel for 20 seconds.

Both saws feature similar rip fences. To set them you slide them into position, then carefully press the fence clamp against the front edge of the table to assure proper alignment. Only then can you tighten the locking knob. While this is not as fast or as easy as the self-aligning fence on a full-size table saw, it will allow for straight, precise cuts if you work by the numbers.

I can't say the same for the miter gauges. Both fit so loosely in their slots on the table that cuts can be off as much as a few degrees. If you want to do accurate work with either miter gauge, you should peen its guide bar on an anvil to spread it until it's wide enough to fill its slot without side play.

Overall, which is my favorite saw? For in-home bench-top use I would pick the Craftsman. It's lighter, cuts more smoothly, and makes much less noise than the Rockwell. If I needed a portable table saw for more ambitious construction work, I'd lean toward the Rockwell for its greater capacity and power. For use in most home shops, however, either one of these saws would make a fine choice.

BAND SAWS

The band saw is one of my favorite power tools. Of course, it's great for cutting curves, but I also use my full-size band saw for a lot of other work. That's why I was particularly pleased to have a chance to put a pair of compacts to work in my shop. I tested the Edison 10-in. band saw and the Austrian-made Emco BS-2.

Right off I was impressed by the fact that both these saws can do things my full-size saw can't. The Edison has a variable speed control and the Emco a three-speed belt drive; so both can cut metal when fitted with the proper blade. My full-size saw requires about 50 bucks' worth of optional speed-reducing hardware to do the same job.

Another nicety: Both band saws have a slot in the table that takes a miter gauge and lets you cut miters and right angles accurately, and the Edison has a second slot, at right angles to the first, that lets you use the miter gauge as a rip fence as well.

How do the two saws compare? The Emco is clearly of higher overall quality. It has more power (five vs. three amps), greater throat depth (14.3 vs. 10 inches), and greater maximum thickness capacity

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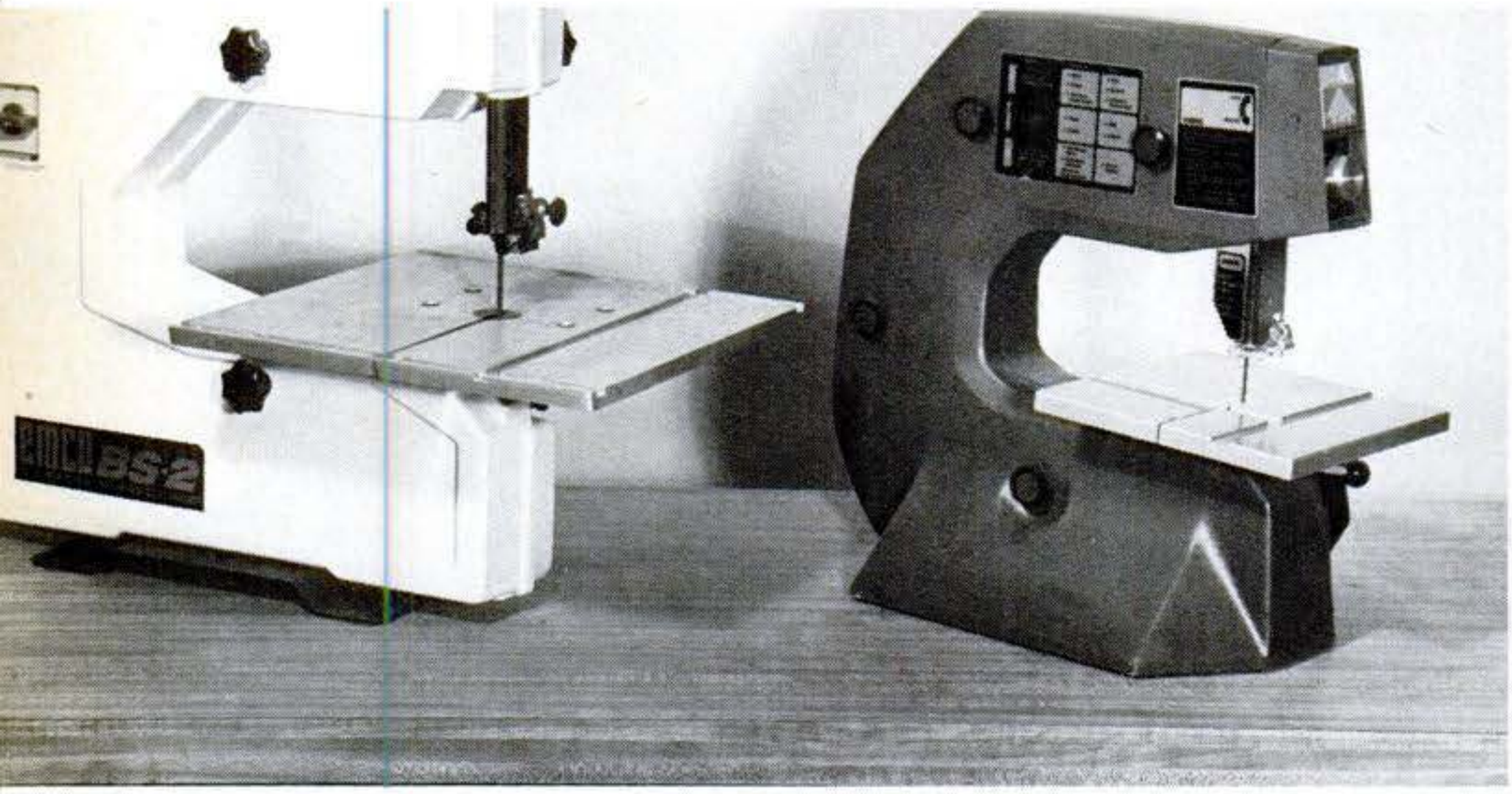


Emco BS-2 and Edison 10-in. band saws (left and right, above) both have three-wheel design, giving relatively deep throats for such small saws. The Emco, sold by Brookstone for $495, is the better saw, but the Edison is a much better value at $150. Both have variable speeds and cut metal without difficulty. Edison band saw has a slot in the table running at right angles to the blade that lets you use the miter gauge as a ripping fence (above right). A screw through the miter-gauge blade into the table locks your setting. Edison changes speeds by means of a dial on the housing (lower right); with the Emco you must remove housing cover and shift a belt from one pulley to another to change speed.

(5.7 vs. four inches). The Emco has a larger table and high-quality blade guides with a ball-bearing guide roller. Large thumbscrews adjust the guides and roller. Edison's blade guides suffer in comparison. A simple metal plate rather than a bearing backs up the blade and adjustment requires a screwdriver.

On the other hand, the Edison performs almost as well as the Emco. It is slightly smoother under no load and cuts at about the same rate and with the same degree of accuracy. It's lighter and easier to carry and store, and is far less expensive. I doubt it would hold up as long as the Emco under heavy use, but for occasional use at home it is a better buy.

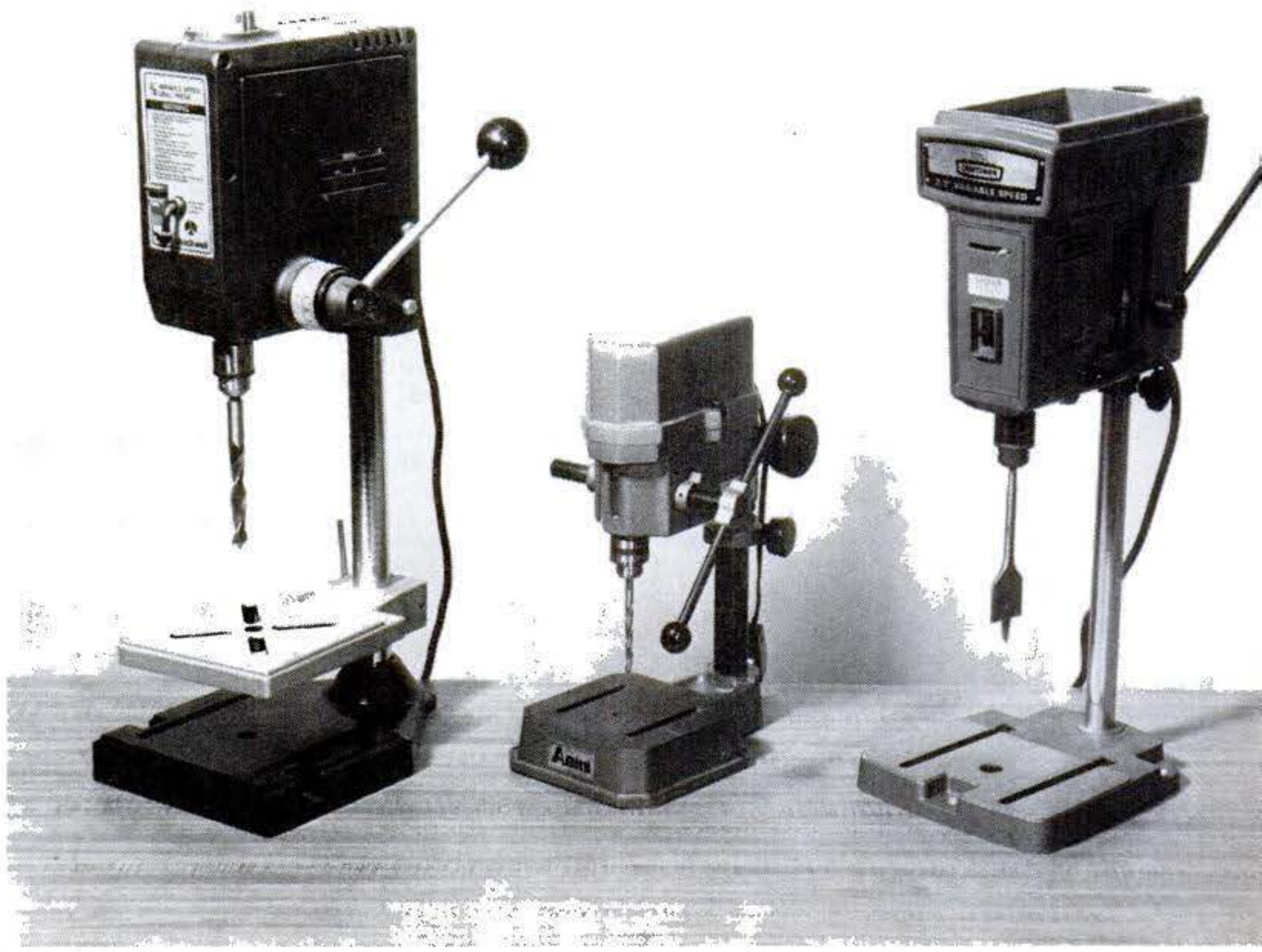
Both saws can take wood- and metal-cutting blades up to about ⅜ in. wide. Neither manufacturer offers a skip-tooth blade—the fastest-cutting wood blade—but you could easily get a skip-tooth made up at any saw shop. A skip-tooth blade is a definite asset if you do much resawing or work with wood over an inch thick.

One last note: If the band saw is a new tool to you and seems a bit scary to use, you'll be glad to know that both of these tools come with good instruction manuals. They help you to understand the workings of the saws, tell you how to set them up properly, and how to use them safely and effectively.

DRILL PRESSES

The main job of a drill press is to bore holes accurately and cleanly. The best of the three I tested is the little Japanese-made Amini. Unfortunately, this tool is too small to handle a full range of workshop chores. While it is perfect for model-making and precision metalwork, it bogs down when the going gets heavy. I found I could stall its motor using finger pressure on the chuck when drilling through wood. This limited capacity, plus a relatively high price, rules the Amini out of contention for general shop use.

That leaves the Rockwell Model 10 and the Sears Craftsman ⅜-in. Portable, and you can't go wrong with either one. Both have almost identical features and work capacities, and both will handle the same jobs with equal aplomb. But they certainly go about things in different ways.



Rockwell and Craftsman drill presses (left and right) are more appropriate for most shop work than the smaller Amini (center), sold by the Fine Tool Shop (Carriage Hill Rd., Westport, Conn. 06880) for $150. The Rockwell sells for $125, and the Sears for $68.50. All three presses have quality geared chucks and variable speeds.

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SANDERS

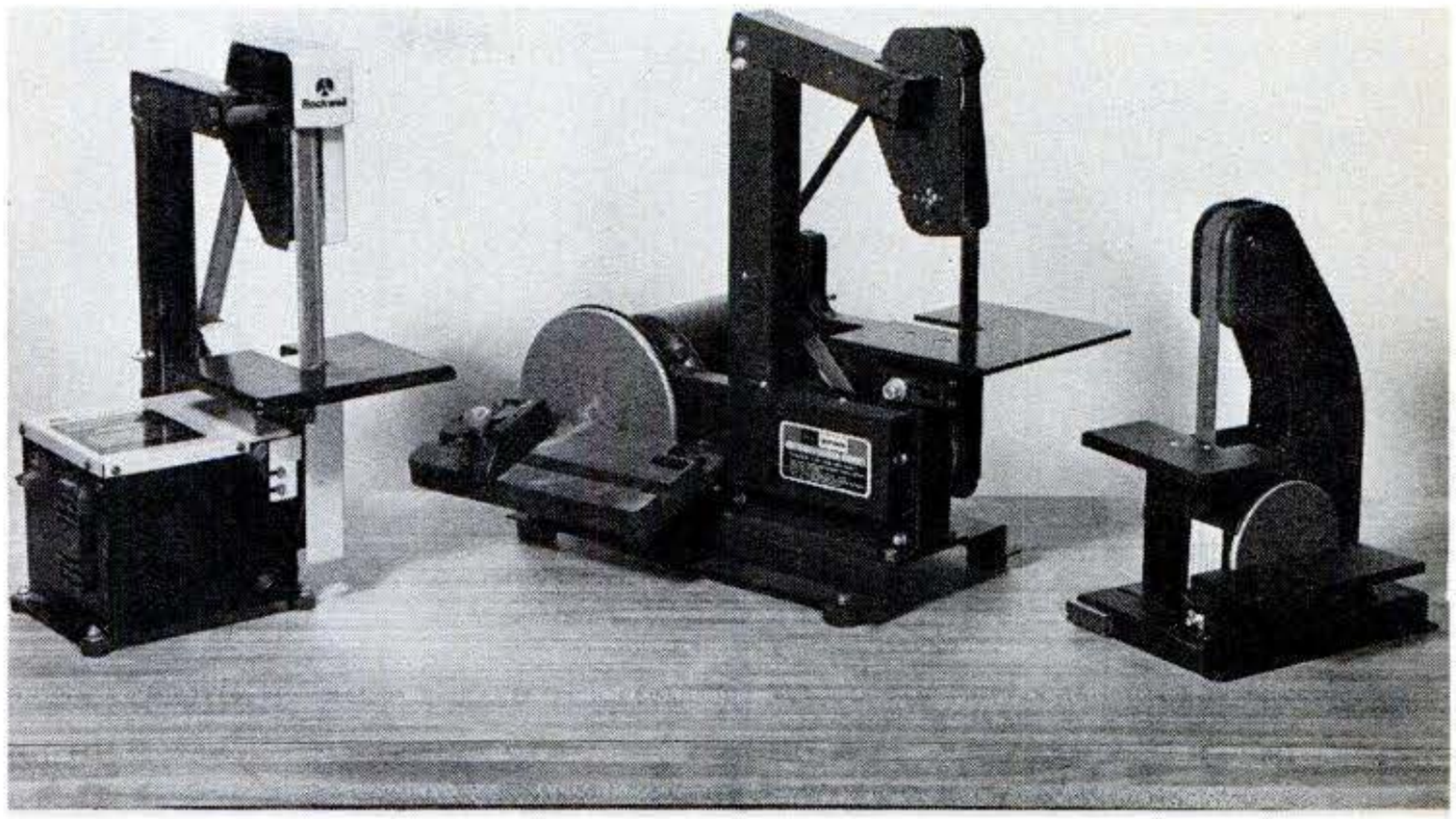
Most of the tools I've discussed so far have been roughly equivalent to one another, but with these sander/grinders you have a wider range of choices. The Dremel is clearly the lightweight: fine for delicate work or model-making, but underpowered for serious shop work. It has only a two-amp motor. If you want a compact grinder with lots of guts, you'll have to choose between the Rockwell and the Sears.

In terms of power, the Rockwell has the edge. I could not stall this tool even by forcing a block of oak against its speeding belt. The same treatment will bring the Sears sander to a reluctant halt. The Rockwell also has an assortment of different platens to back up its belt, including some half-round types good for sanding concave surfaces.

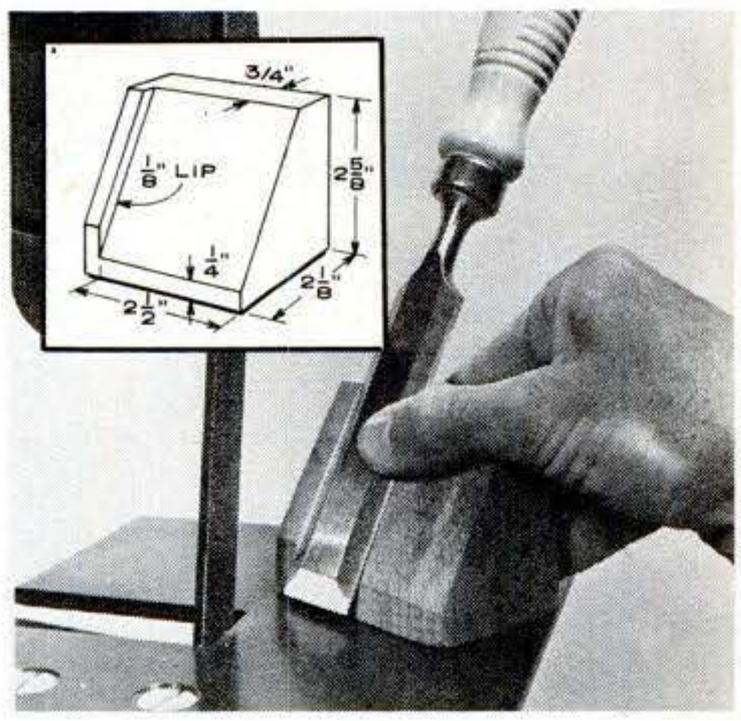
The Sears tool costs about $50 more than the Rockwell, takes up more space and weighs considerably more. On the plus side, it is much quieter, takes an accessory disc sander, and will do inside sanding without the need for add-ons (the Rockwell requires an idler assembly).

No matter which tool you pick, you'll discover it has a very useful combination of power plus the ability to do fine work. I especially like these tools for sharpening. By grinding my plane irons, chisels, and gouges on the one-inch belt, I get good control and rarely overheat an edge. A simple wooden guide I devised helps me get the grinding angles that I want (see photo).

If pressed for my favorite between the two models, I'd say take the Sears if you want disc-sanding capabilities; otherwise, buy the Rockwell and save money.



Rockwell, Sears, and Dremel sanders (above) all have one-inch-wide belts. Dremel (at right) is light-duty but comes with disc sander. The Sears Sander/Grinder (center) is shown with its optional disc and costs about $180 with the attachment. The Rockwell (left) and the Dremel each sells for $100. All three can sand inside edges without problems.

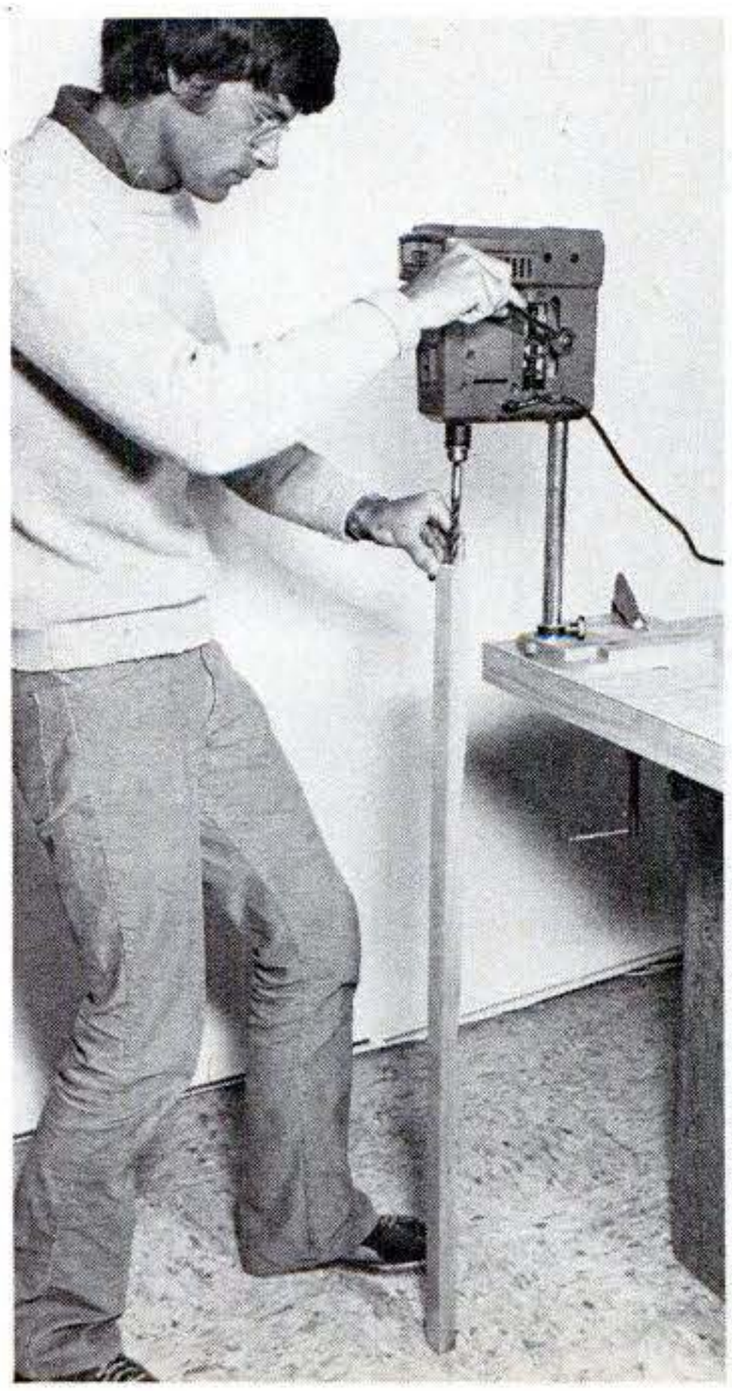


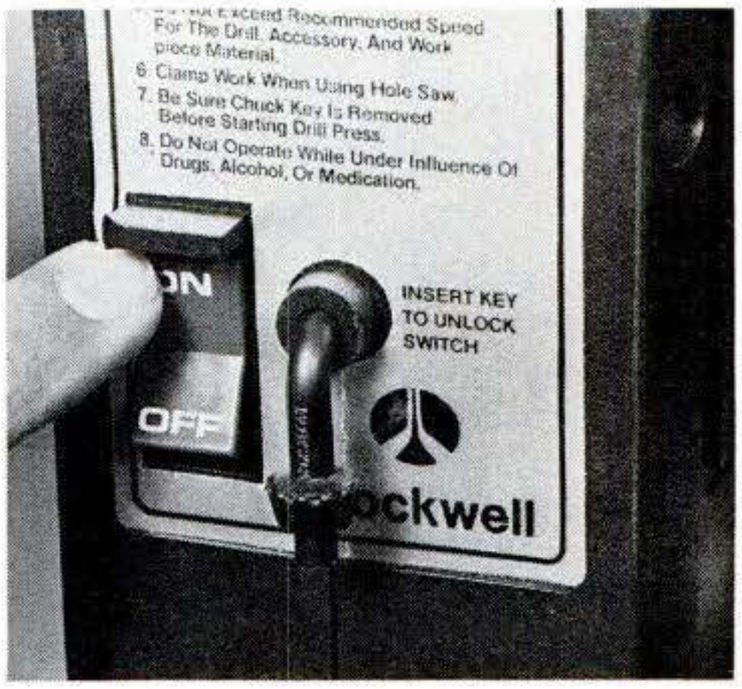
Sander/grinders are great for sharpening chisels, gouges, and plane irons (right). The simple guide shown here makes it easy to hold the correct bevel angle. Construct the guide as shown in the sketch (inset). The adjustable tilting table on each model can be used to alter the bevel.

For example, Rockwell has a conventional quill-type work stroke while the entire power head of the Craftsman moves when you swing the lever arm. The Rockwell has an adjustable table and a base; on the Sears the base doubles as the table. The Sears has a variable-speed motor; the Rockwell has a constant-rpm motor and several pulleys to control bit speed. None of these differences gave either tool any significant edge over the other, however. Neither did the Rockwell's slightly greater power (three amps vs. 2.4). Both presses could drive a 1¼-in. spade bit through fir with no trouble.

The Rockwell has a slight edge in swing capacity (chuck to column distance) but the Craftsman has a slightly longer work stroke. About the only real difference between the two: The Rockwell's depth stop is a bit quicker to set than the stop nuts on the Sears.

I first thought the Rockwell could drill cleaner holes with greater accuracy, but when I tightened a loose setscrew in the Craftsman's head, it performed as well as the Rockwell. The loose screw had allowed the head of the Sears press to move slightly from side to side, creating considerable chatter with spade bits. Once I solved that problem I could find no real reason to favor one tool over the other.





Chuck keys on the Rockwell and Craftsman drill presses (above) must be removed from the chuck and then inserted in a special hole beside the on-off button before the tools will run. No more flying chuck keys, no more unauthorized use.

All small drill presses can handle long work if you use them off the edge of your bench as shown here at left. All the benchtop tools shown on these pages should be secured to the bench by some extra means; here a C-clamp is used.

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Lodge with solar roof

Modified A-frame overcomes north-wall heat loss by dropping roof to ground

By AL LEES

The popularity of the A-frame plunged as the energy crisis accelerated. Those long, sharply canted roof/walls were not only inefficient in terms of floor space; they funneled heat up to the unoccupied peak—not a functional feature for a year-round retreat. But architect Samuel Paul came to PS with an intriguing proposal:

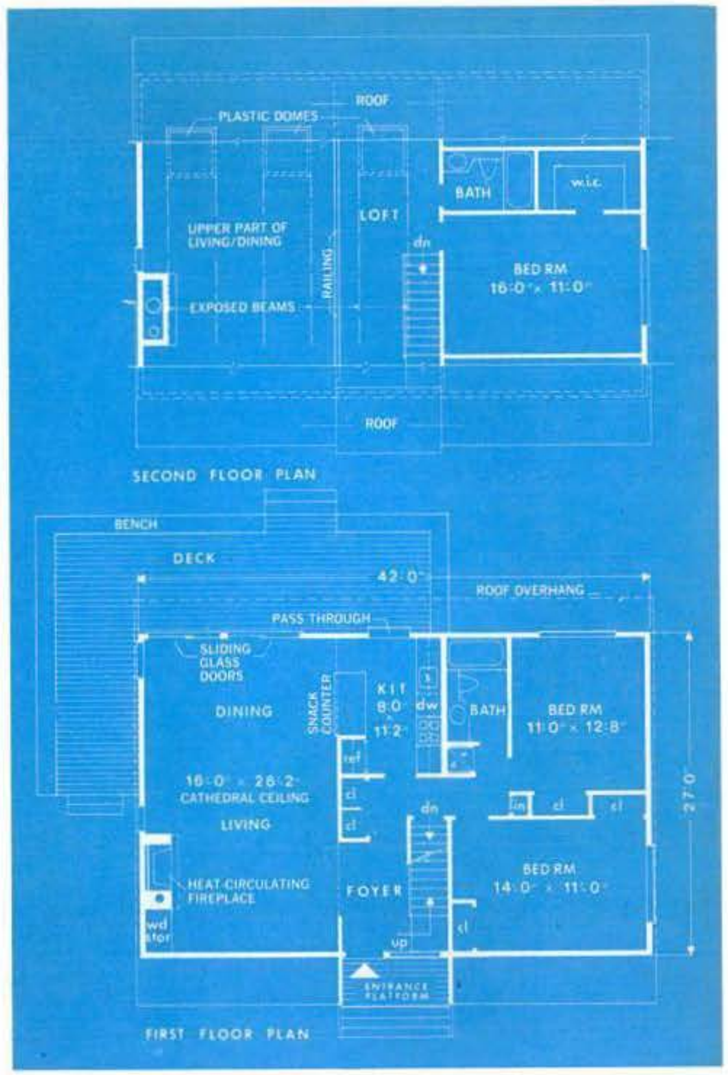
"Let me take the A-frame and shift the ridge back to create a steep windowless rear wall and a more gradual slope for a battery of solar collectors on the south-sited roof. Let me raise that roof's eave onto a conventional vertical wall—with lots of glass beneath a projecting brow. The overhang will shade this glazing from high summer rays but let low winter sun slip under. And the effect inside will be the reverse of the old A-frame with its all-glass gable end and blind side walls. My solar roof will also feature sky domes for light and direct heat gain for the main living area. Further light for this space will come from a floor-to-peak strip of fixed windows beside a chimney for an efficient fireplace."

To justify that 27-ft.-high peak, Paul stacked a master bedroom (with bath) and an ample access loft atop the two downstairs bedrooms. Between that upper ceiling and the roof peak, he tucked an air plenum with an exhaust fan to pull accumulated hot air out of the full-height living area. A louvered vent in the far gable carries this air outside. These vents are closed during winter.

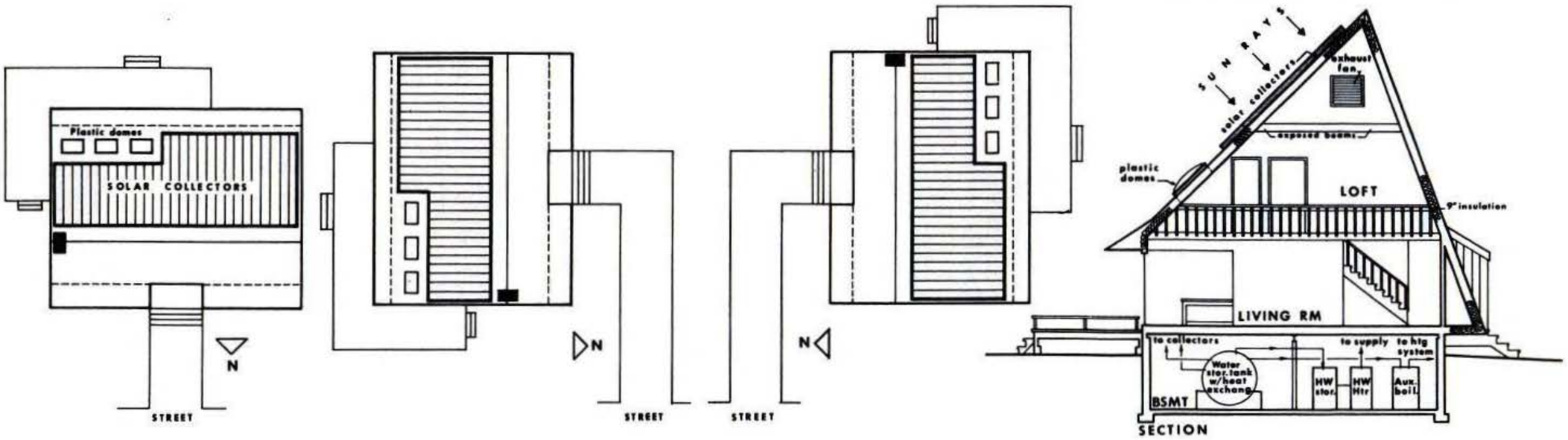
An air trap of another sort is found at the base of the blind north roof/wall. As shown in the section, the unusable floor space on both sides of the entry bay is partitioned into dead-air chambers to further insulate the interior. Square footage: first floor, 1134; loft, 529. PS

How to order your plans

One set of detailed, professionally drawn blueprints for this house is $65; five sets (for construction, financing, obtaining permits), $95; materials list and specifications included at no extra cost. An additional mirror-reverse print can be ordered for $10. Address orders or queries to Homes for Living, Inc. (specify Berkshire Plan), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add $3 for postage and handling.



Site orientation is vital to the function of any solar design. Collectors should face due south, but 30-degree deviation is allowable. Ways of placing house on lots with different accesses are shown in first three sketches at right. Fourth sketch is section looking toward sleep loft, to right in floor plans. Exposed tie-beams are above living/dining area only. Peak above bedroom ceiling is exhaust plenum.



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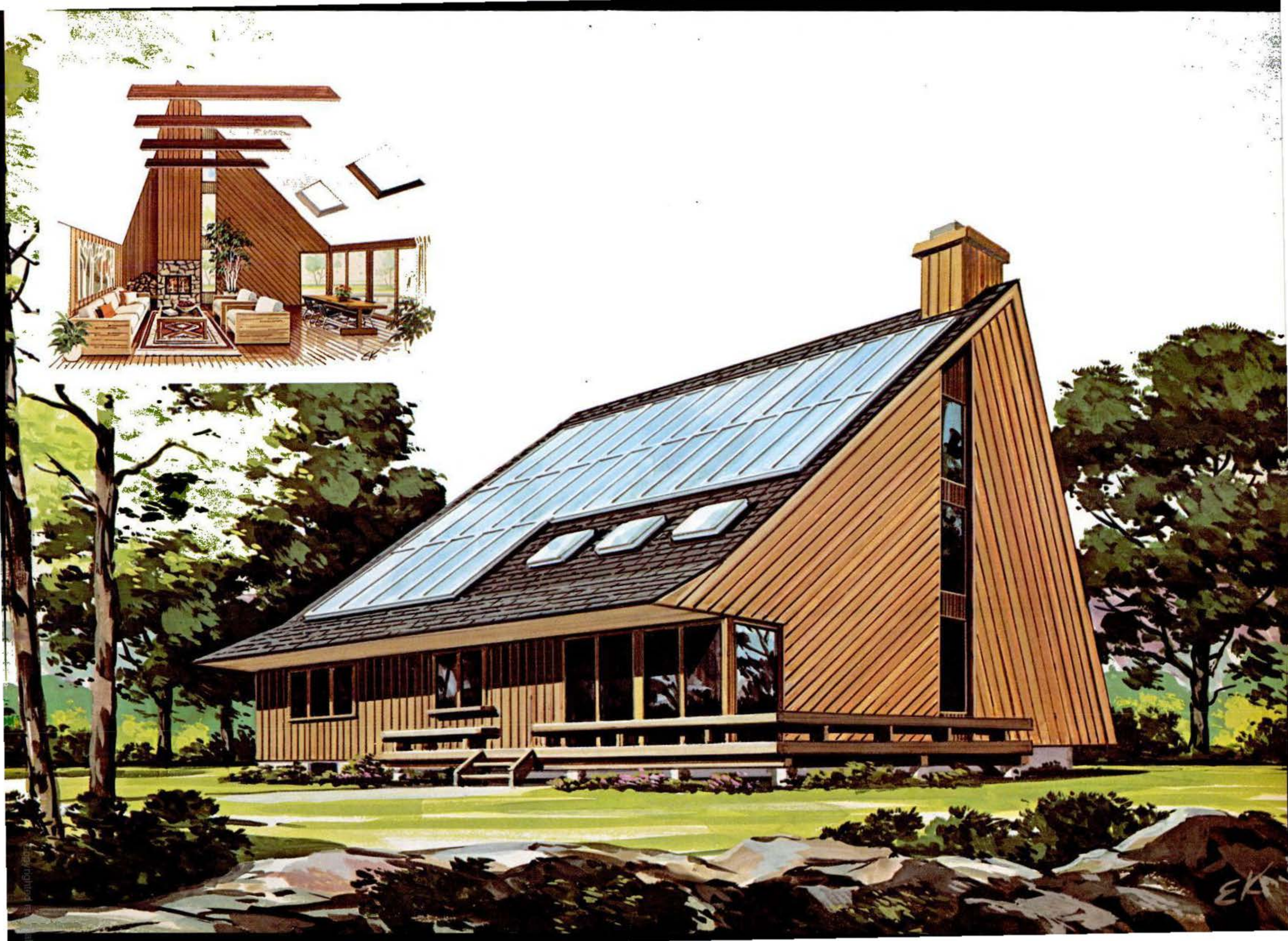


Backyard solar-heated workshop

Passive-solar design (with wood-stove backup) keeps this year-round shop cozy

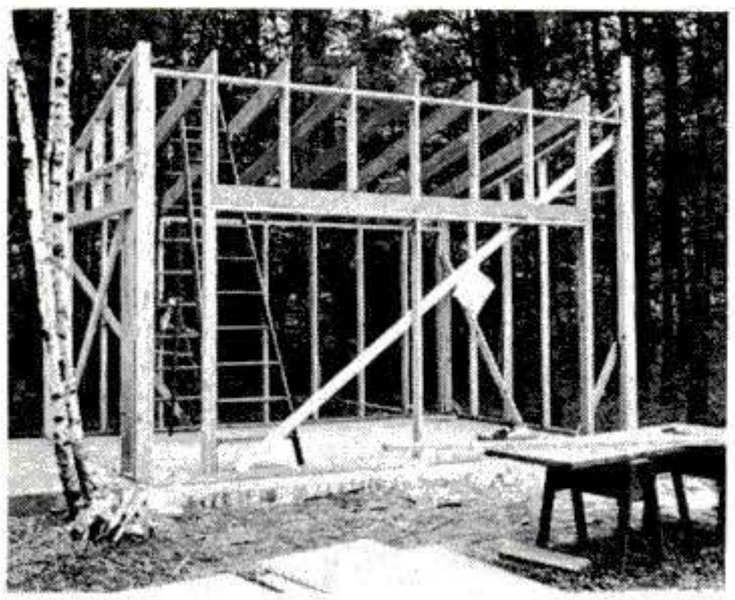
By JEFF MILSTEIN, architect
DRAWINGS BY CARL DE GROOTE

It's no fun to work in a backyard shop in the middle of winter. That's what I realized after I designed and built my first workshop [PS, June '73]. Though I'd designed that first shop only for warm-weather use, once I had it I found that I wanted to use it throughout the year. During winters in upstate New York, where I live, keeping the shop barely warm required constant feeding of a wood stove. When I recently moved a few miles from my former residence and PS asked me for another workshop design, I determined to build a shop that would be convenient to work in all year long.

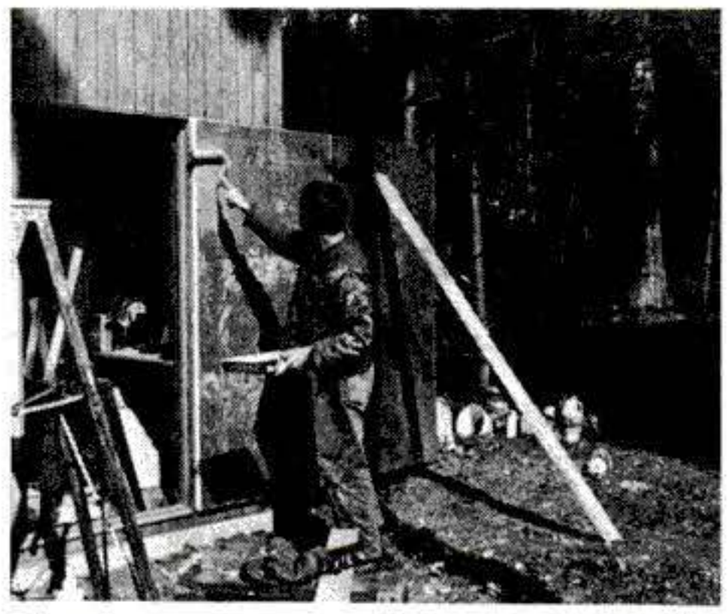
The energy crunch and my interest in small, efficient buildings led me to investigate solar heating, even though my site was less than ideal. After studying the major books in the solar-heating field, I decided that the best solution for me was a direct-gain passive system. This arrangement makes the most sense for a small, inexpensive structure. Since the building itself is the collector, there's little added cost over normal construction materials, no extra for solar hardware.

In my design, sunshine passes through large fixed windows and heats a dark concrete floor slab and the earth below it. To retain the heat, the floor slab and foundation are insulated from the surrounding earth around the perimeter. Ceiling and walls have only normal insulation, and doors and shutters are weatherstripped as usual. The only moving parts of my heating system are the folding, insulated shutters that cover the windows.

At my site, on short winter days the sun is full on the workshop at 9:30 in the morning. Some shade trees (I am as yet unwilling to cut them down) filter most of the afternoon sun after 1:30, so the shop misses about two hours of midwinter sun. I calculated that due to my site restrictions I am garnering only 60–65 percent of the available winter insolation. Even so, I think my results are impressive.



Shed framing can be one-man job. Workshop's walls were assembled on slab, raised, and braced by author alone. Short 2×8 rafters required two simple cutoffs.



Aluminum paint on inside of shutters reflects extra light into shop. Shutters hang from jamb on four-inch strap hinges, with two-inch butt hinges between panels.

Solar performance

After I open the shutters each morning, the workshop warms up quickly. The inside temperature will rise as much as 30–35 degrees by 1:30, and I close the shutters to hold the heat. The gain is seven to 10 degrees per hour on a bright day. This gain depends on the clarity of the sky, not the outside temperature (see table). After the shutters are closed, the temperature in the shop falls an average of one to two degrees per hour overnight.

This means that the shop is not only comfortable to work in until late in the evenings, but the heat gain is cumulative. After several successive sunny days, when I open the shop in the morning it will be 10–20 degrees above the outside temperature. The shop reaches a top temperature of about 65 degrees if it's 25 outside. When it's 40 outside and sunny, the shop temperature rises well into the 70's. I calculate that, with optimal siting, inside temperatures of at least 70 degrees could be achieved in 25-degree weather.

As a backup when the temperature falls below zero or the sky stays cloudy for several days, I installed a small wood stove, an airtight Petit Godin No. 3731 [see PS, Jan., page 123]. I found an outside air-supply vent necessary, though, to keep the stove from gulping heated shop air.

Solar planning

For the solar design, I used a rough rule of thumb of one cubic foot of storage material to one square foot of glass collector. After seeking some expert advice, I reduced the glass area to

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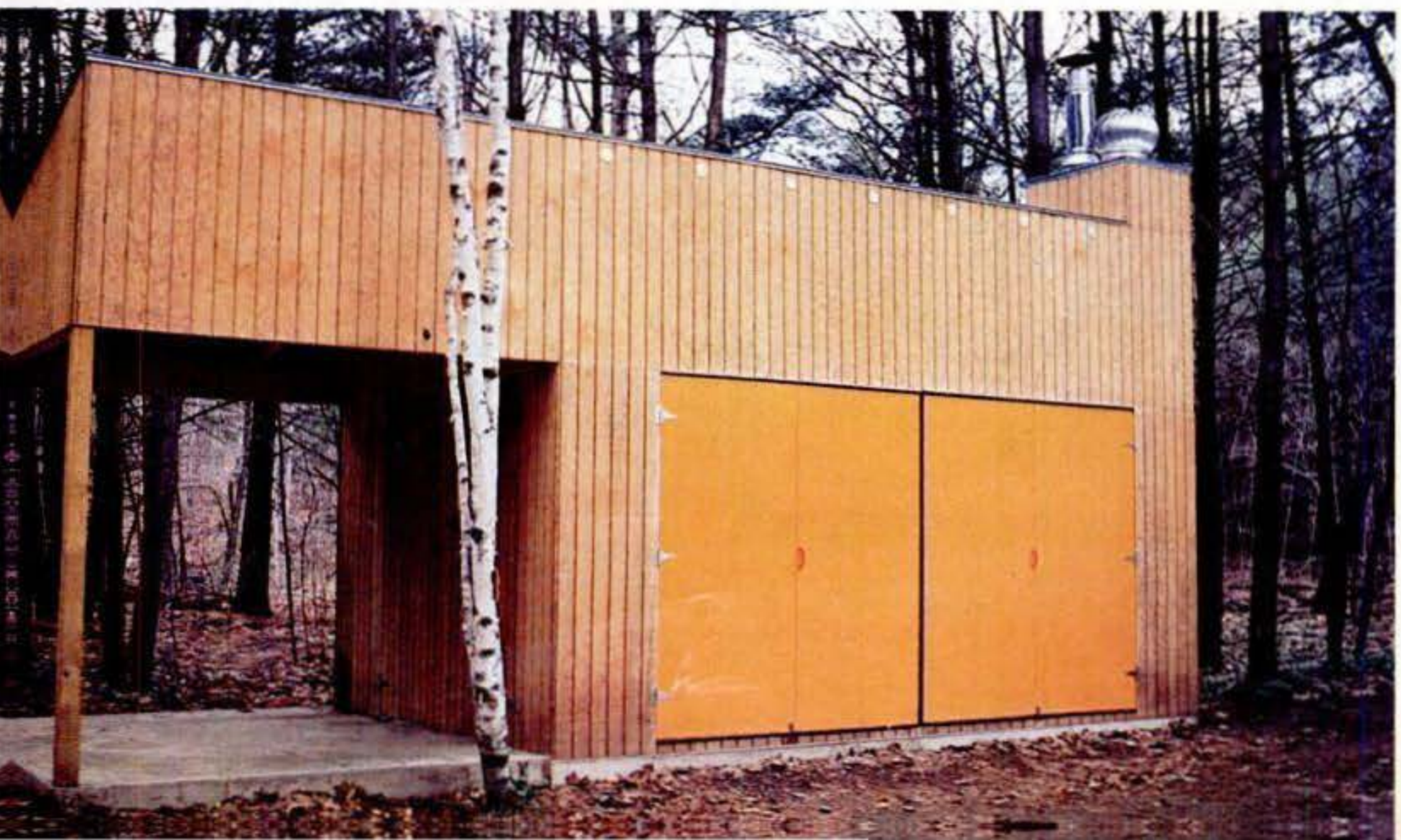

Interior of shop (above) has space for Sears table and band saws and plenty of counter area. Concrete floor is painted flat black to absorb sunlight entering window (left). Workshop actually heats up best when snow reflects extra sunshine. Two doors to shop are under covered porch: small entry door to minimize heat loss, and extra-wide one for bulky materials and summer ventilation.

avoid overheating in midday sun when outside temperatures wouldn't be too low—say, in the 40's. I had planned to pour a one-foot-thick concrete slab, but, after figuring the total expense of that much concrete at today's prices, I reconsidered. I remembered that some solar projects have included earth as a heat sink under a floor and found it to be almost as good as masonry in holding heat. I decided to make a thinner slab and depend on the gravel and earth underneath to store any extra heat.

The shed shape was chosen for simplicity of construction and function. The sloped ceiling would move warm summer air up to the belvedere where it could be vented. The high south side also makes the shop seem much bigger and more comfortable.

Construction

To lay the foundation, I had a backhoe dig a one-foot-wide, 3½-foot-deep trench around the shop and porch area. A two-foot-wide trench of the same depth was then cut to separate the porch and shop slabs. Two-by-fours were set around the outside of

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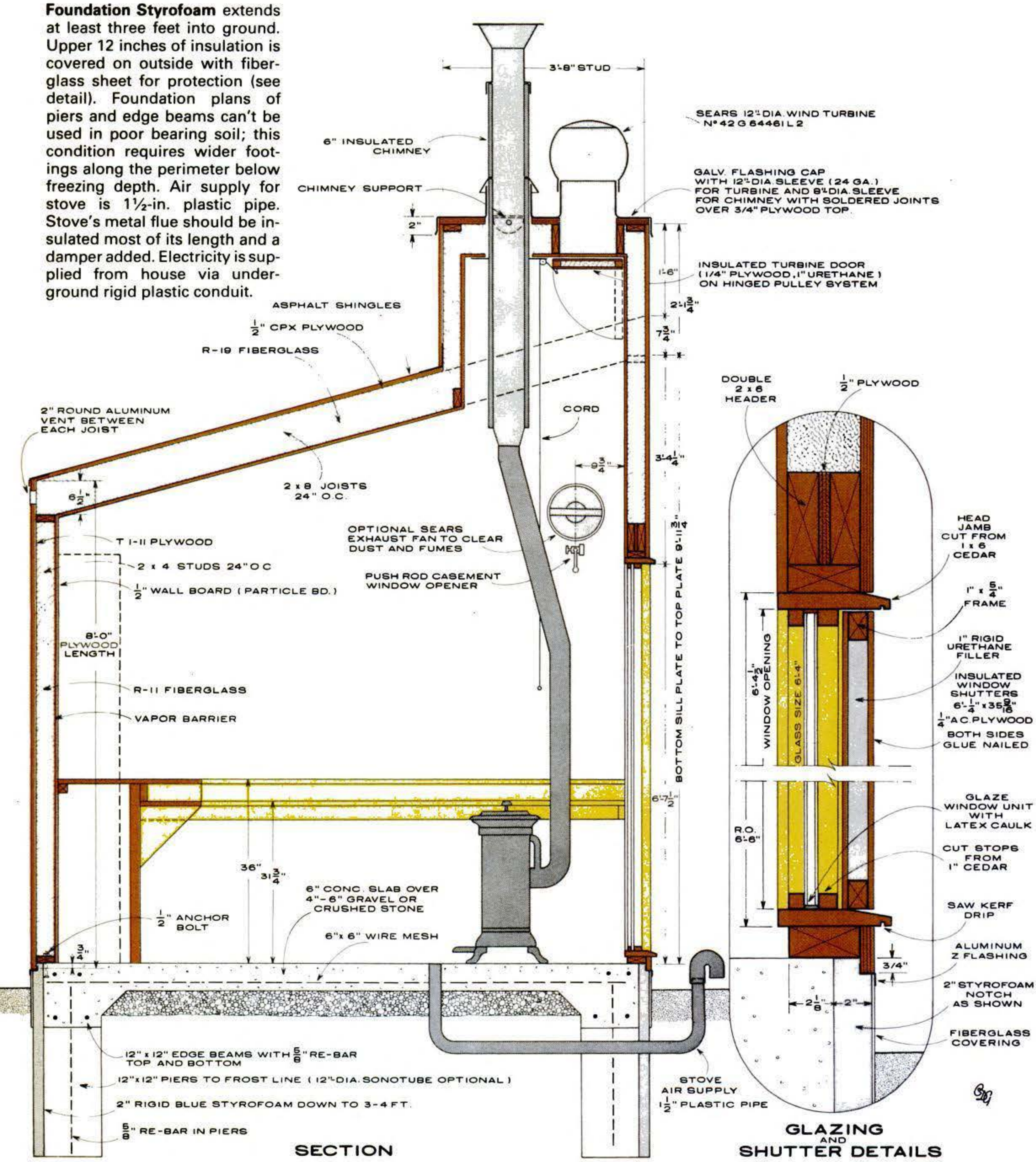
the trench and down the center of the two-foot trench and leveled several inches above grade. Tongue-and-groove, two-inch-thick blue Styrofoam—the only type specifically for insulating below grade—was taped to the inside of the 2×4's flush to the top, creating a form for the concrete. Forms for the piers were made from plywood, but Sonotube, a ready-made cardboard product available through most lumberyards, would work as well. After the pier forms were in place, the ditch was partly backfilled and tamped, and gravel was laid over the fill (see drawing). Steel reinforcing bar in the piers and edge beams was then wired in position and 6×6 wire mesh laid to strengthen the slab floors.

The foundation and slabs were filled in a single pour to the top of the Styrofoam. Half-inch bolts for anchoring the 2×4 sills were set in the slabs near the edge. A pressure-treated 2×4 was used in the form between the porch and shop area and left in place after pouring.

Walls of 2×4's on 24-inch centers were assembled on the slab and raised

Foundation Styrofoam extends at least three feet into ground. Upper 12 inches of insulation is covered on outside with fiberglass sheet for protection (see detail). Foundation plans of piers and edge beams can't be used in poor bearing soil; this condition requires wider footings along the perimeter below freezing depth. Air supply for stove is 1½-in. plastic pipe. Stove's metal flue should be insulated most of its length and a damper added. Electricity is supplied from house via underground rigid plastic conduit.



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into place (except for the south wall, which was built in place after the end walls were up). Double 2×4's were used around the door and fixed windows. However, built-up 2×3 posts were used between shutter jambs, so the insulated shutters could fit flush to the outside wall when closed. The workshop and doors were faced with ⅝-inch T1-11 plywood (grooved 4-in. o.c.) nailed directly to the studs. As a siding material, T1-11 dispenses with the need for a separate sheathing. Although foam sheathing is being used to increase insulation in some construction, I didn't think it necessary for my small structure.

The shed roof was framed with 2×8 rafters. Insulation between rafters was fiberglass R-19, with R-11 in the walls. A heavy plastic vapor barrier was stapled over walls and ceiling. Roofing materials were the usual asphalt shingles and felt over ½-inch exterior plywood sheathing. Inside walls were covered with ½-inch particleboard.

Shutters were constructed of 5/4-inch #1 pine stock with one-inch rigid urethane sandwiched between ¼-inch AC plywood on both sides. Windows are sealed, double-glazed, tempered glass—standard replacement panels for sliding glass doors. The glass panels were fit in their jambs and held with one-inch stop on either side and caulked around the edges to prevent infiltration.

The belvedere required heading off a single 2×8 rafter and framing in the rest of the box structure with 2×4's. A Sears wind-driven turbine ventilator was installed at the top of the belvedere for summer ventilation, and an insulated chimney support added beside it for the stove flue.

The roof of the belvedere is a single sheet of galvanized metal with short collars soldered on around holes for the flue and turbine ventilator. The flashing sleeves for each were then slipped over the collars and set in a generous layer of butyl caulk.

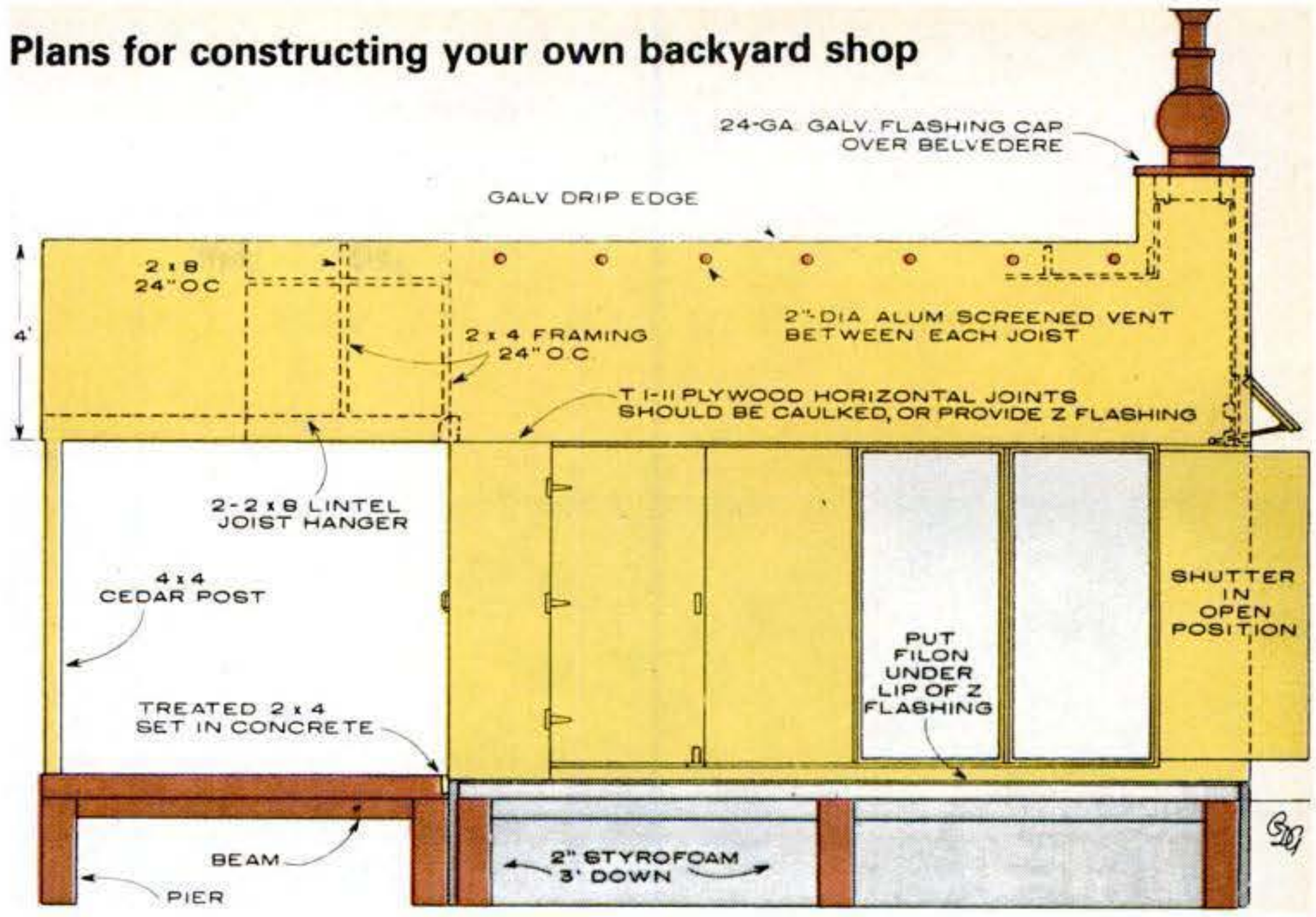
An exhaust fan was added on the side wall just below the belvedere to clear solvent fumes and dust. Urethane-insulated covers similar in construction to the shutters were built for the turbine throat and the exhaust-fan opening during winter. To preserve the siding's natural look, I applied a clear water-repellent sealer. The exterior face of the shutters was primed and painted with bright latex house paint. PS

MANUFACTURERS LIST

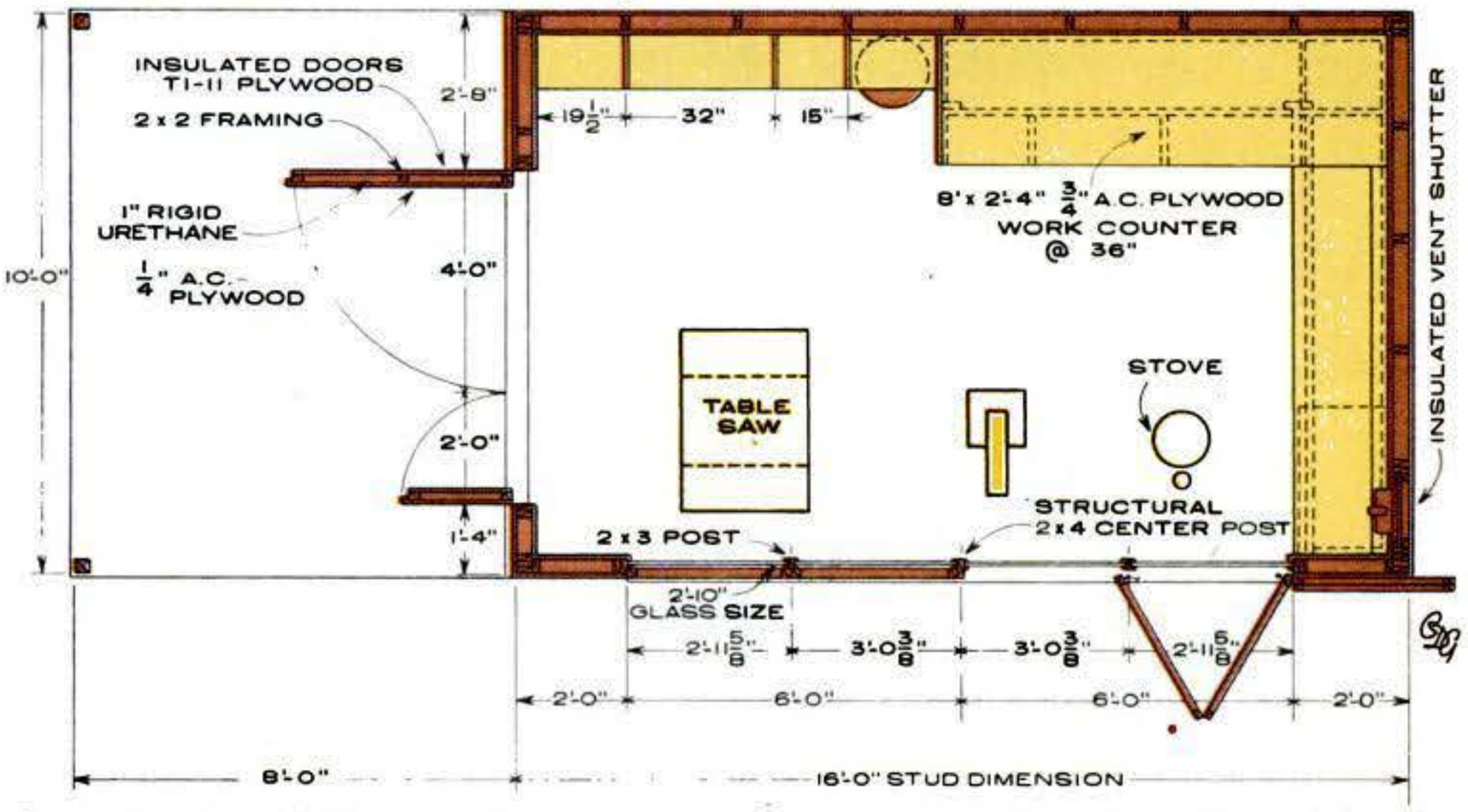
For more information about products mentioned in this article, write to the manufacturers listed below.

American Plywood Assn., Box 2277, Tacoma WA 98401 (T1-11 siding); **Bow & Arrow Imports**, 14 Arrow St., Cambridge MA 02138 (Petit Godin stove); **Dow Chemical**, 2020 Dow Center, Midland MI 48640 (Styrofoam); **Sears**, Sears Tower, Chicago IL 60684 (shop tools, fan, and turbine).

Plans for constructing your own backyard shop



Two-inch-diameter air vents high in wall between rafters keep insulation moisture-free. Glass in fixed windows is tempered double-glazed, sliding-door replacement. These replacements are the cheapest source of large double-glazed stock.



Porch doors and folding shutters are insulated with rigid urethane. Doors are framed with 2×3's and covered with siding outside, ¼-in. AC plywood inside. Shutter framing is 5/4-in. stock with ¼-in. plywood glued and nailed on both sides.

Workshop's performance on successive midwinter days

	Time of day	Outside temp.	Inside temp.	Total gain
Day 1 (partly cloudy)	9:30 AM 1:30 PM 7:00 PM	21 21 15	26 56 40	30
Day 2 (sunny)	9:30 AM 1:30 PM 7:00 PM	17 26 25	30 62 47	32
Day 3 (hazy)	9:30 AM 1:30 PM 7:00 PM	27 38 38	34 55 46	21
Day 4 (sunny)	9:30 AM 1:30 PM 7:00 PM	32 44 32	38 61 52	23

Workshop gains seven to 10 deg./hr. on sunny days, 9:30–1:30, when site limits insolation. Gain is cumulative on successive days, for higher peak temperatures.

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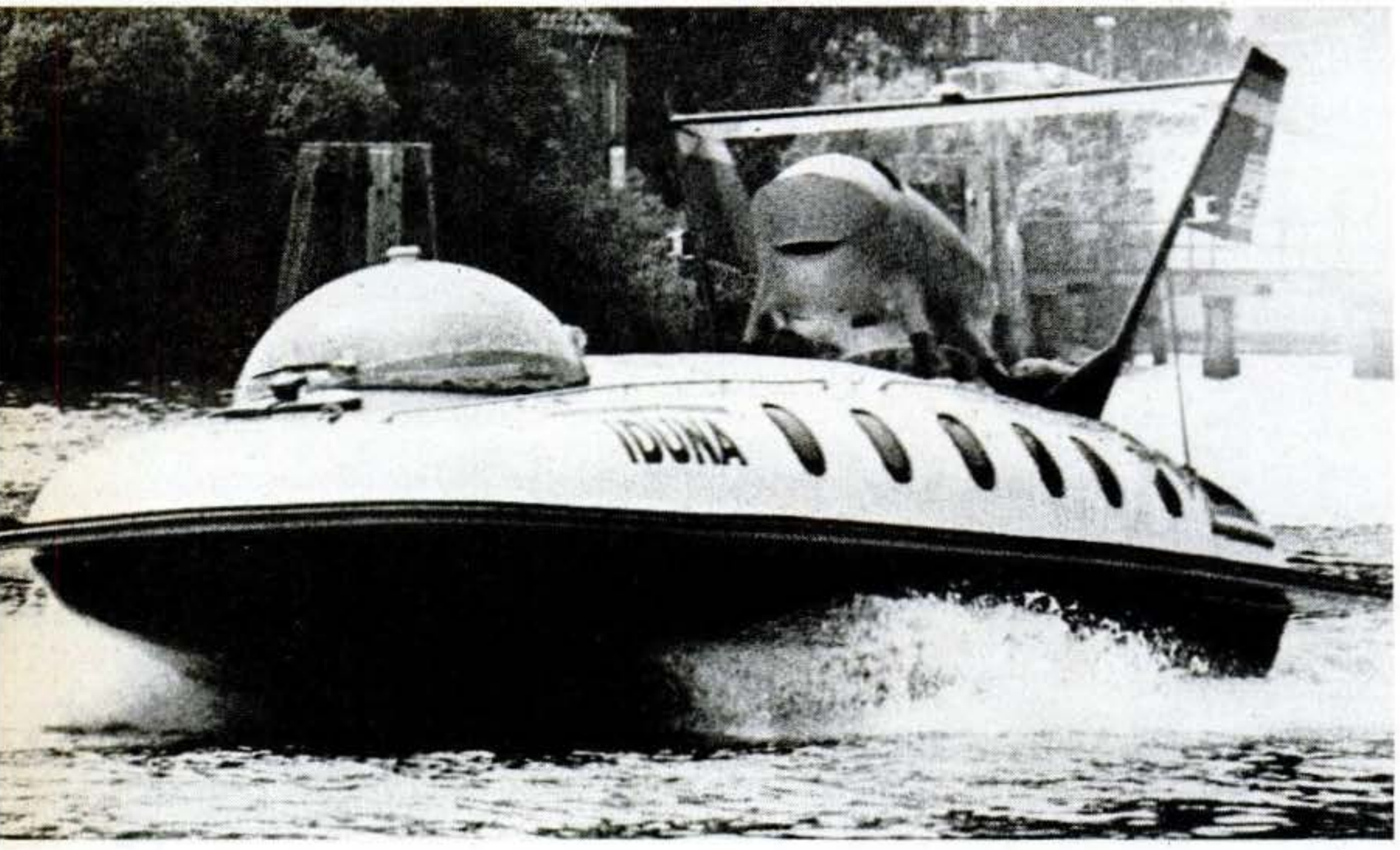
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Lithium light

Stash Moonlight away and up to 10 years later the compact flashlight will still work, says the maker. The long-life secret is a lithium cell that also gives 15 hours of light. Price: $17.50. Early Winters, Ltd., 110 Prefontaine So., Seattle, Wash. 98104.

Flying boat

Passengers sit in airline-type seats while this new German "flying" boat planes along the water surface at 25–55 knots. Hamburg's Rolf Schmidt designed a round-bottom craft instead of a costlier hydrofoil or hovercraft. Propulsion: propeller, aircraft turbine, or pump.

Motorized belt

Close the door and this belt automatically secures you. Some 1982 Toyota Corona models will have this motorized shoulder harness. A collision locks the belt in place. The belt moves forward for easy exit or entry when you open the door. A manual lap belt will also be provided.

Three aerodynamic imports

Alfa Romeo borrowed aerodynamic concepts from racing cars for its limited-edition Sprint Veloce GT coupe (left, top). Reinforced-fiberglass parts reduce drag, while spoilers boost wheel traction. Renault's sleek Fuego GT fastback (middle) seats four and has a big wraparound tailgate window. The front-drive coupe replaces the Renault 15 and 17. Ford's Italian Granada Altair (bottom) has a super-slippery body to reduce wind drag. It has an impact-absorbing bumper and deep spoiler up front. Three ducts channel engine-cooling air.

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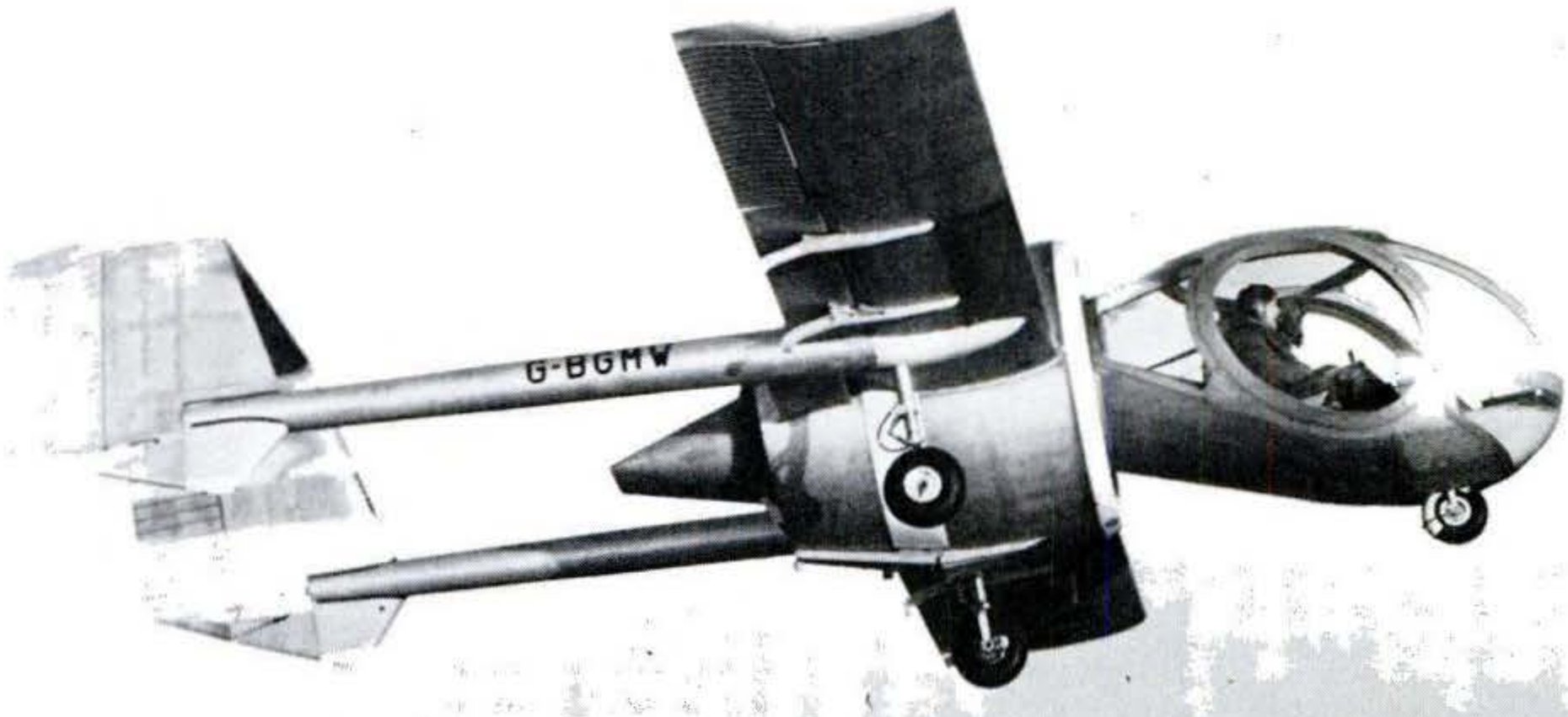


Pocket microscope

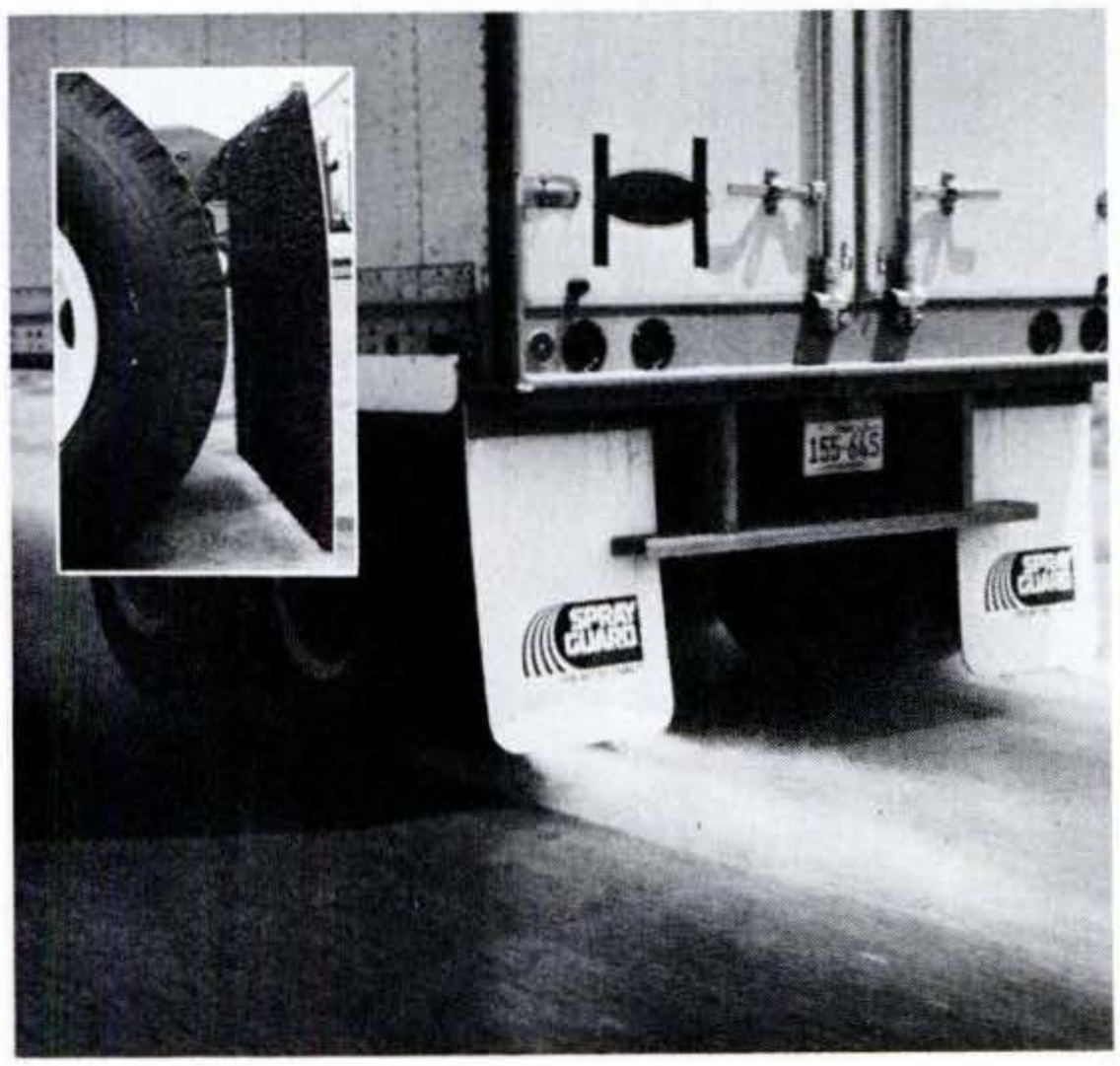
Need to study objects up close? Micro-Mike is a pocket microscope with a 20X prefocused optical system. The field is flat and undistorted with a bright image, says the maker, General Scientific Equipment Co., Limekiln Pike & Williams Ave., Philadelphia, Pa. 19150. $8.95.

Slow plane

Bug-eyed British Optica plane can poke along at 45 mph, thanks to low loading from its 39-foot wing span. The slow-motion aerial-survey plane can be operated more cheaply than a helicopter. A 150-hp engine drives a five-blade propeller. Cruising speed is 120 mph.

Fruit bag

Picking time for fruit is halved with the Picker-Pocket Bag, according to its British developers. A wire ring keeps the bag open. Arm-held bags come in 1¼- and three-quart sizes. A waist-level bag for large fruit has a chute from the arm. Garden Way, Charlotte, Vt. 05445.



Rain flaps

Does spray from passing truck tires obscure your highway view? Spray Guard rain flaps on trucks can improve visibility, says Monsanto. Instead of a hard surface, which creates spray clouds, the new flaps have a grass-like plastic coating (inset) to minimize spray.

Electric bike

Throw a switch on this experimental bike and a tiny 0.3-hp battery-powered motor provides electric assistance on hills or in crosswinds. The motor, which runs only when a rider pedals, drives an auxiliary sprocket through gearing. Lucas in England developed it.

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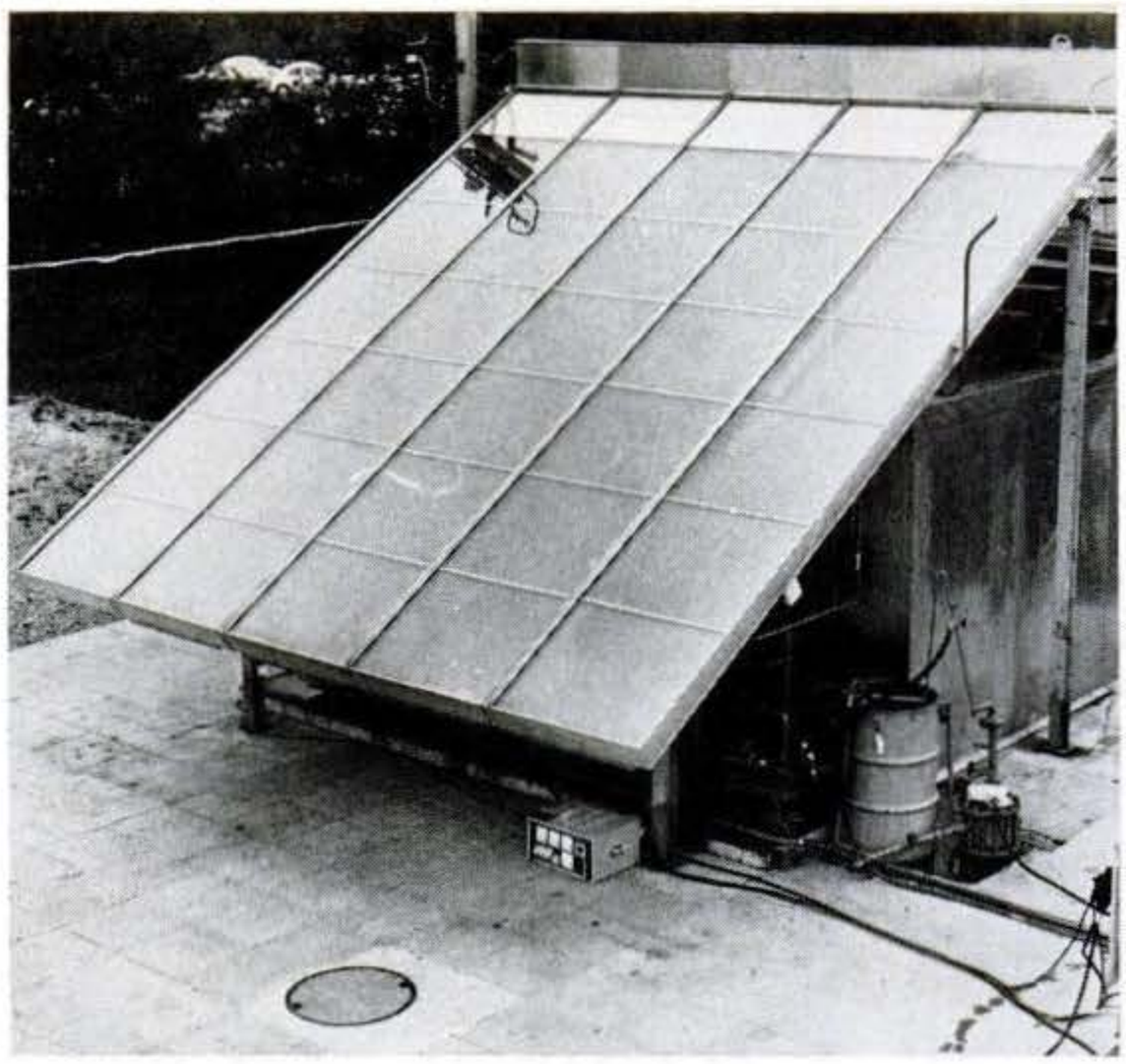
What's New

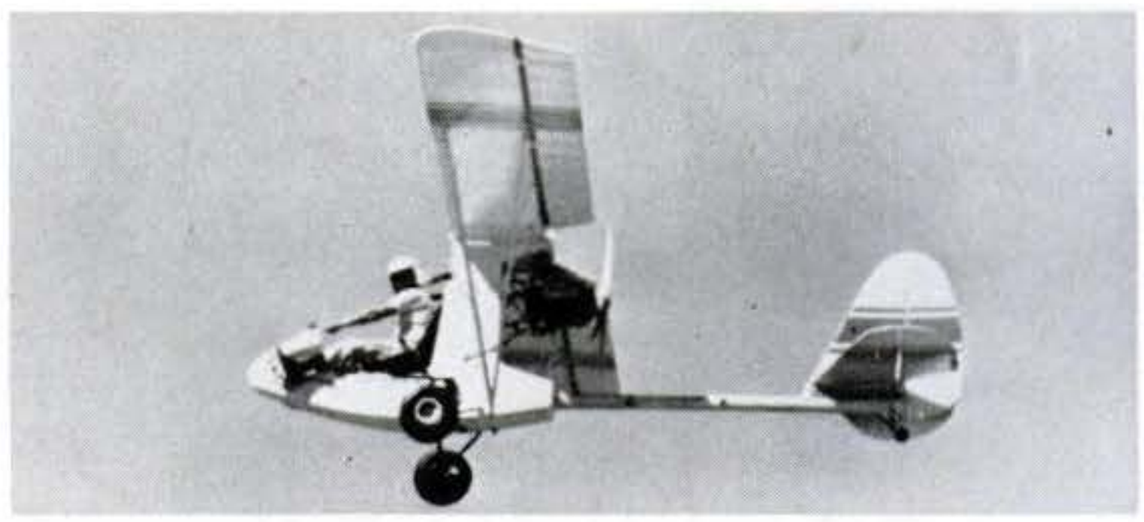
Solar cooler

Tucked under a 22-sq.-meter solar panel is a 12-cu.-m refrigerator. There are no moving parts. Solar heat separates an ammonia-water solution; then ammonia acts as working fluid, transferring heat from the room to the water coolant. Germany's Dornier developed the system for test in Egypt.



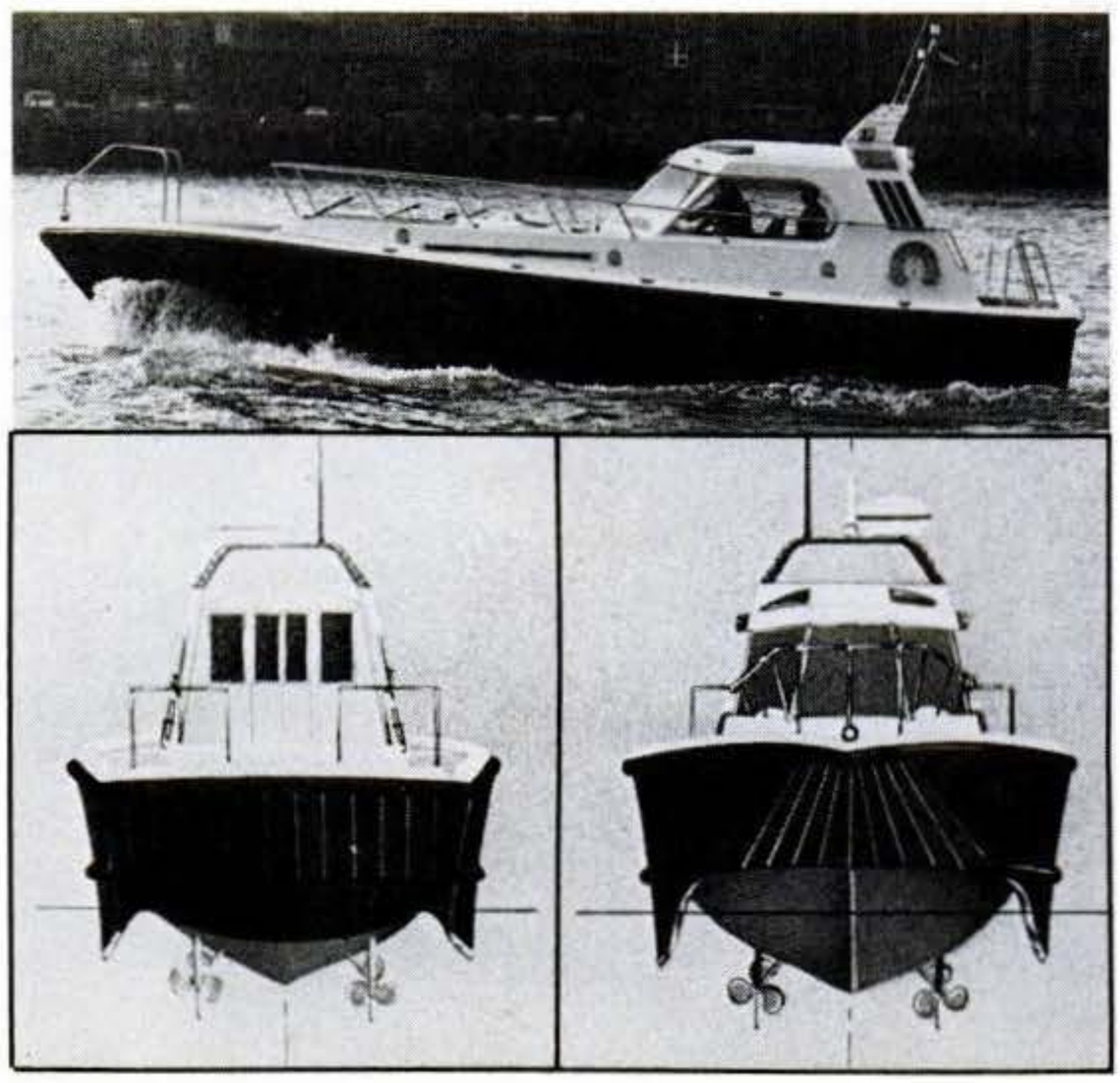
Flatproof tire

Bike-path booby traps can't puncture this tire's inner tube, says its maker (Glamor Prod., 2075 S. Valentia St., Denver, Colo. 80231). It's made of natural rubber, with a hollow core. The $13 tube also keeps the tire at constant air pressure despite temperature changes.



Open-cockpit plane

The pilot gets plenty of fresh air in this new homebuilt, pusher-prop plane. Powered by a 1385-cc VW engine, the Beta Bird cruises at 130 km/h, does STOL maneuvers at 70 km/h, and has a 290-km range, says designer Bob Hovey (Box 1074, Canyon Country, Calif. 91351). Plans are $60.



Uplifting hull

The speedy new Tyler Vortex 43 has twin fore-and-aft hull tunnels. These trap the bow wave, guiding it under the boat to reduce drag and add hydrodynamic lift. This improves both hull efficiency and mph, claims Tyler Marine, Morley Rd., Tonbridge, Kent, England.

Cozy camp pad

Your sleeping bag won't slither off this new, reinforced-polyethylene pad. Its specially embossed surface also makes the pad highly resistant to heat loss, moisture, dirt, ice, and sunlight, says Frelen Corp. (491 Dutton St., Lowell, Mass. 01852). The flexible, 0.5-kg pad is $12.

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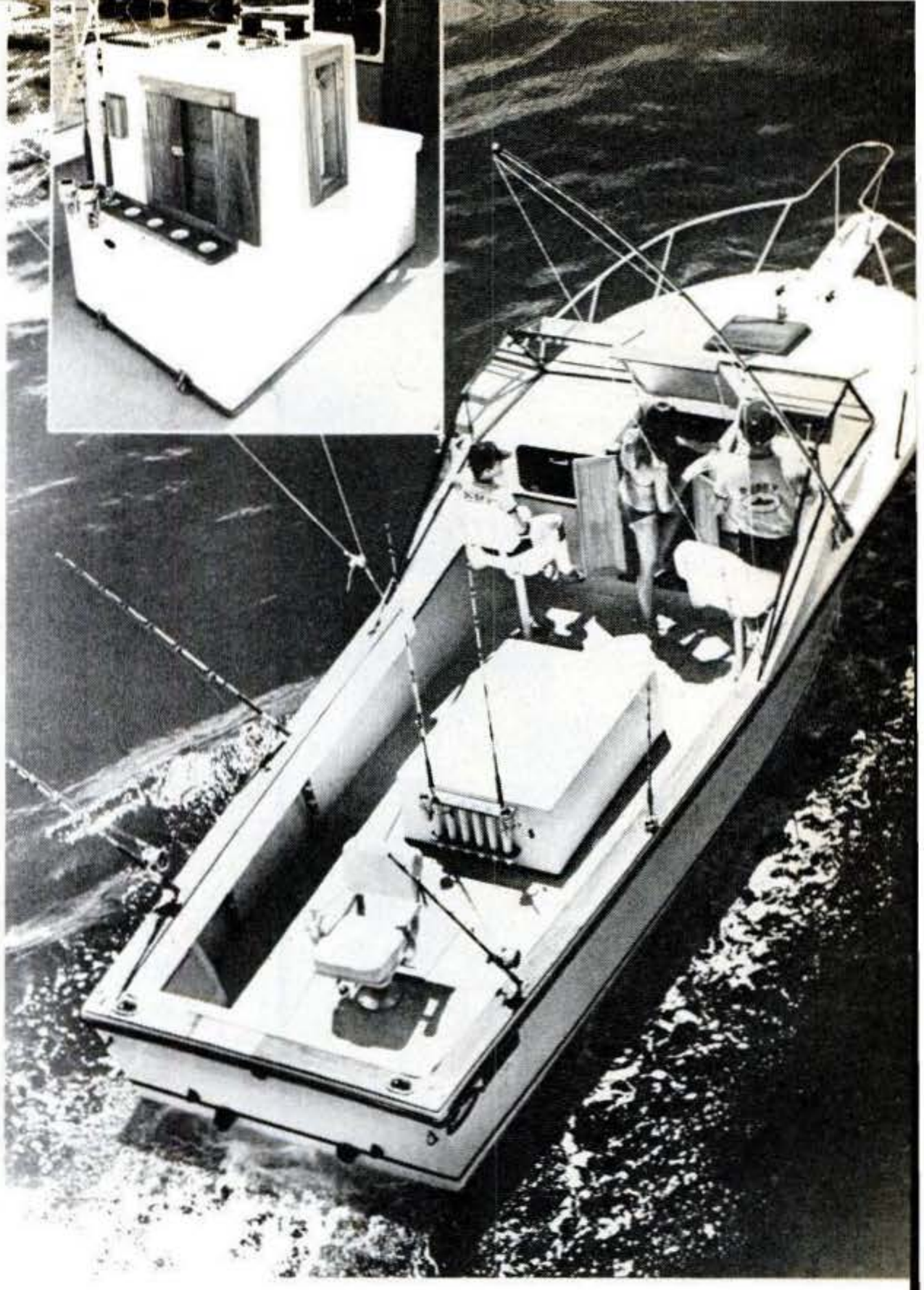
What's New IN BOATING

BY SUSAN RENNER-SMITH

Comfortable fisherman

Designed for the family-centered angler, the Dusky 25-ft. Cuddy combines cruising comforts with serious fishing. The cuddy cabin has two V-bunks and a head, along with overhead rod racks. The wide-open cockpit has room aft for a full-size fighting chair. On inboard models, an optional custom motor box (inset) provides extra bench seating. The box also holds an insulated ice chest and sink as well as rod racks and stowage locker. Prices start at $7950 (outboard hull), $12,000 (gasoline inboards), and $19,000 (diesel power). Dusky Marine, 110 N. Bryan Rd., Dania, Fla. 33004.



Tiny transceiver

Practically palm-size, the one-pound Catalina 600 radiotelephone is only 6.5 in. high and 2.8 in. wide. The three-watt, six-channel unit comes with two crystals, nicads and charger, and a sturdy "rubber ducky" antenna. Pearce-Simpson, 5101 N.W. 36 Ave., Miami, Fla. 33142. $490.

One-handed winch

Designed for small boats, this self-tailing winch has a vertical "stripper arm" that tensions the sheet before it's fed to the jaws atop the winch drum. The gearless device has an 8:1 power ratio, says the maker (M.S. Gibb, Warsash, Southampton S03 6ZG England).

Echo gun

Submerge the nose, pull the trigger, and the Fish Ray's built-in transducer shoots down a sonar beam. A digital LCD at its other end shows bottom depth—or fish—to 99 ft. The $160 unit floats and is waterproof. Morrow Electronics, Box 7078, Salem, Ore. 97303.

Morse light

Flashing a brilliant SOS visible for miles, the electronic Signa-Flash can operate for 44 hours on one set of alkaline D-cells. Waterproof and floatable, the two-pound unit also has a "keep-away" on-off mode. Signa-Flash, 9 Parmalea Crescent, Weston, Ont. M9R 2X8. $100.

Type I MSD

This odd-shaped treat-and-discharge tank fits neatly inside sailboat hulls and up to 15 ft. from the head. The TDX-S works with most marine toilets, and uses only 1.96 amp-hrs. to chemically treat eight gallons of waste. $499. Mansfield Inc., Big Prairie, Ohio 44611.

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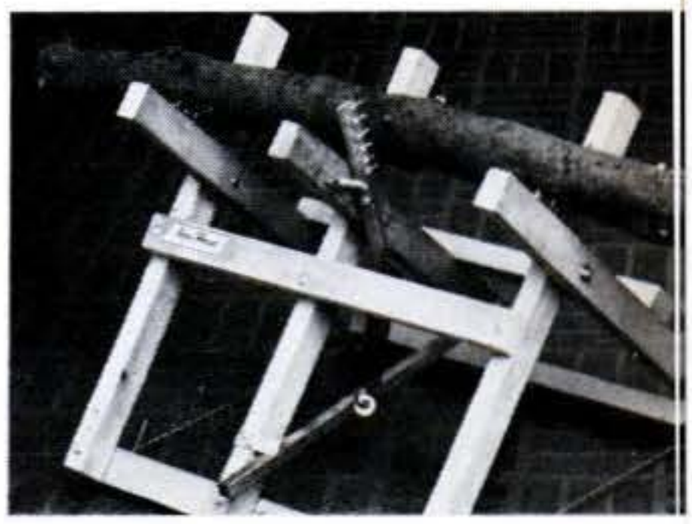
What's New IN TOOLS

BY R. L. STEPLER

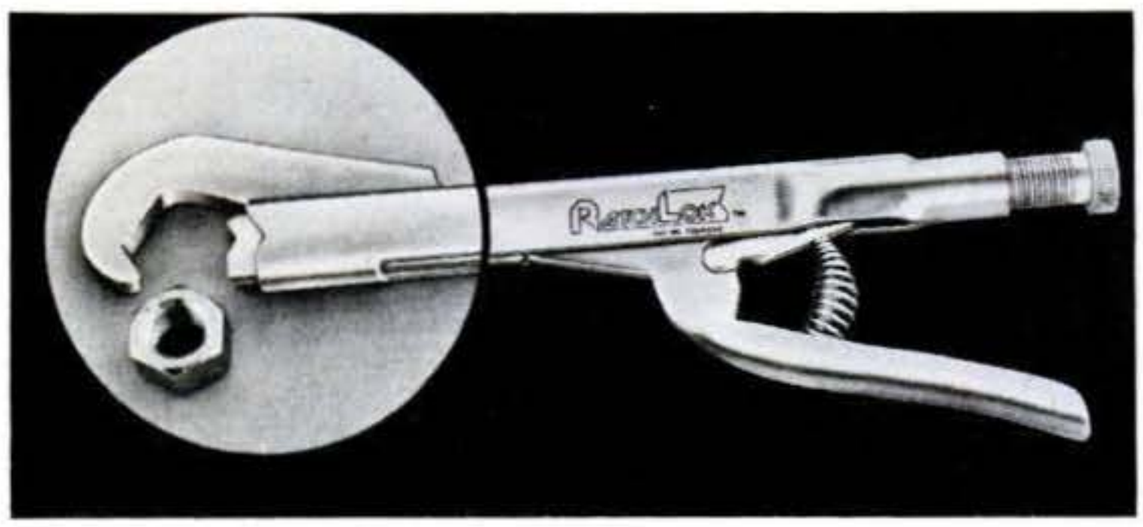


Wood glue

UGL claims its new Woodworkers Glue is nonflammable and produces no toxic fumes. Work can be unclamped after 30 minutes, says UGL, and maximum strength is reached with overnight drying. The glue comes in 4- and 8-oz. and quart and gallon containers.

Sawhorse

Jaw Horse's pedal-operated saw-toothed clamp gets a grip on logs for safer chainsawing. A complete unit costs $65; hardware only (you supply 2×3 frame), $35. From Trem Products Co., 7 Page Rd., Bedford, Mass. 01730.



Well driver

In soft or sandy soils, Little Pounder drives wells up to 50 feet with 1½- or two-inch-dia. pipe, says Crystal Water Products (Box 12867, St. Paul, Minn. 55112). The portable driver weighs 85 lbs., features a ½-hp motor that delivers 96 50-lb. blows per minute.

Gripper

Ratchlok's maker says the adjustable tool's four-sided design gives positive grip on nuts and bolts from ⅜ to 1⅛ in. size. The 21-oz., 10½-in.-long wrench delivers 150 foot-pounds of torque and costs $19.95 from Summit Tool Co., 4150 Fox St., Denver, Colo. 80216.

Stud detector

Needle in a haystack? Find it fast with Black & Decker's electronic metal detector and stud finder. A red light on the device glows when you've located hidden metal objects. A nine-volt battery powers it; less than $15 buys it.

Tiny socket set

Five sockets—3/16 to 5/16 in.—fit inside Pocket Socket's plastic handle. Just 7¾ in. long and 1½ in. wide, the little ratchet slips easily into your pocket. Price is under $20. Maker: New Britain Tool, Box 1320, New Britain, Conn. 06030.

Miller/driller

Enco's metalworking milling and drilling machine has 23 speeds, from 62 to 3220 rpm. The $1436.50 tool has a two-hp motor, a 16⅜-in. swing, 8½-ft.-by-28½-in. table, 1¼-in. drilling capacity, and three-in. face-milling capacity. Enco Mfg., 5000 W. Bloomingdale Ave., Chicago, Ill. 60639.

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What's New IN HOME IMPROVEMENT

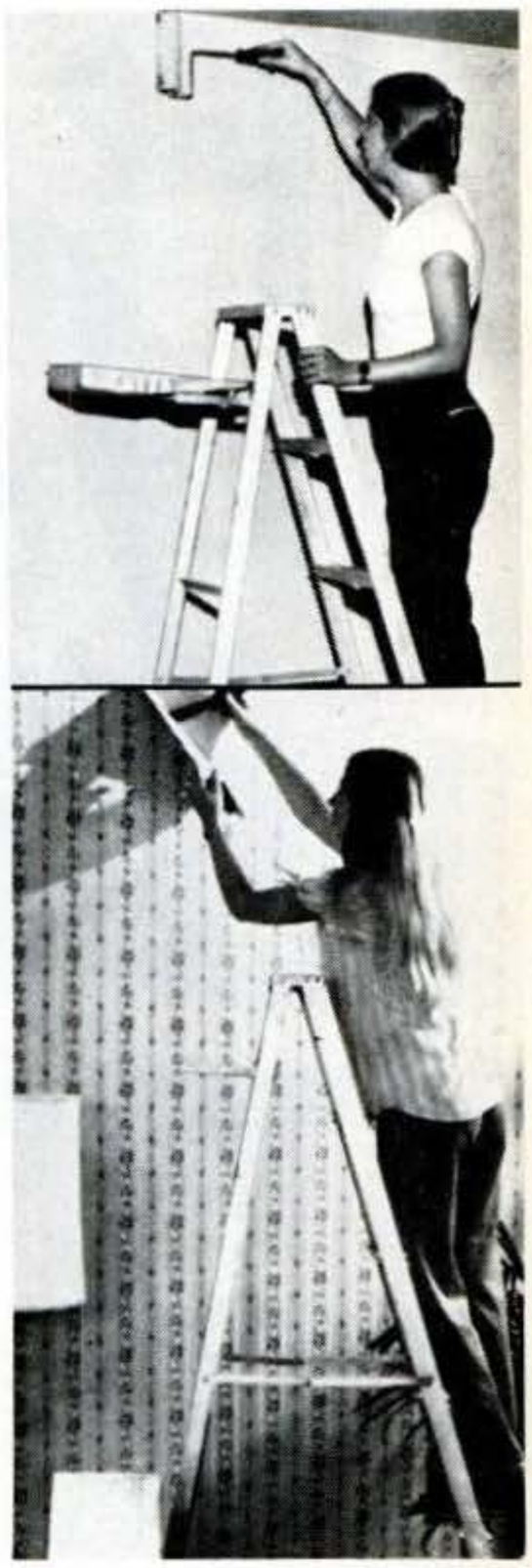
BY R. L. STEPLER

Dishwasher

GE's GSD2500 uses solid-state electronics and LED's to give you a visual indication of energy consumption. The computerized dishwasher lets you program 25 combinations of wash, rinse, and dry cycles. Built-in diagnostic circuitry aids in servicing.

Undercoating

Peelz release coating lets you dry-strip any wall covering—even years later, says William Zinsser & Co. (39 Belmont Dr., Somerset, N.J. 08873). You roll it on (top), let dry one hour, then apply wall covering. Wide-blade scraper (bottom) starts the stripping when you redecorate.



Room fan

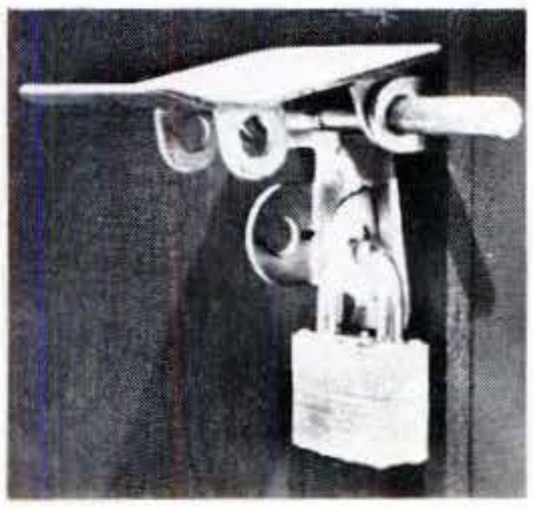
Gyroaire's circular louvers slowly rotate to spread air flow throughout the room. Or lock 'em to direct air in one direction. A variable-speed control circulates 350 to 2400 cu. ft. of air per minute. Price: $69.95. Maker: Mistral Fans, 1311 Blue Gum St., Anaheim, Calif. 92806.

Circular shower

Aquasphere 360's translucent sides flood the shower stall with natural light. And towels stay toasty because hot water flows through chromed towel bars. (Sliding panels keep 'em dry.) Preplumbed Aquasphere fits through doorways, costs $1695. Alsons Corp., 525 E. Edna Pl., Covina, Calif. 91723.

Plank flooring

Country Estate Plank three-ply oak flooring can be mastic-applied over plywood, concrete, asphalt tile, or nailed to wooden subfloors. It comes in 3", 5", and 7" widths and in random lengths. Sykes Flooring Prods., Masonite Corp., Box 999, Warren, Ark. 71671.



Slide bolt

Eleven-gauge-steel center lock fits either the right or left side of a door, features a zinc-plated security shield to protect the padlock. The heavy-duty hardware weighs 1½ lbs., costs $7. Holmes-Hally Ind., 7460 Bandini Blvd., Los Angeles, Calif. 90040.

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What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Digital audio

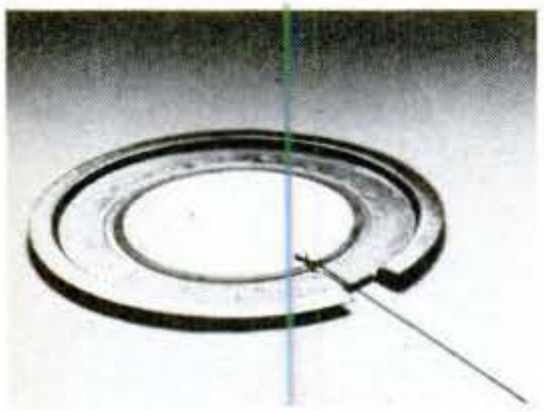
Sanyo's digital audio adapter connects between your hi-fi and video tape deck for the ultimate in audio recording—no distortion, tape hiss, or wow and flutter. The adapter converts the audio to digital signals that literally re-create the original recorded signal. "Plus 10" PCM is $3996.

Number taker

Attach this digital memory box to your phone and up to 10 callers can leave their numbers when you're not home. The caller redials his number at the tone and the box stores it for your return. Feedback Ltd., Park Rd., Crowborough, Sussex TN6 2QR, England.

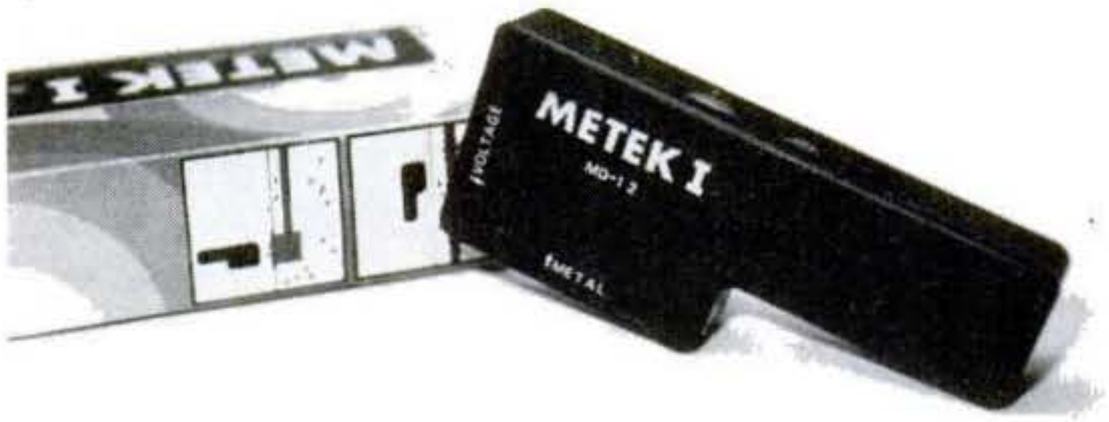
TV tester

To align a TV properly, you need the right signal generators: crosshatch, a scale, dots, and rainbow, to name a few. Now you get those—and seven others—on a hand-sized tester by Hickok (10514 Dupont Ave., Cleveland, Ohio 44108), for $159. It has both RF and video output.



Mini sounder

Making a calculator or other small electronic product play more than one tone is difficult: It takes a space-wasting speaker to reproduce them. This new piezoelectric element from Panasonic can take the speaker's place. It's just one mm thick but can reproduce 500 to 5000 Hz.



Privacy check

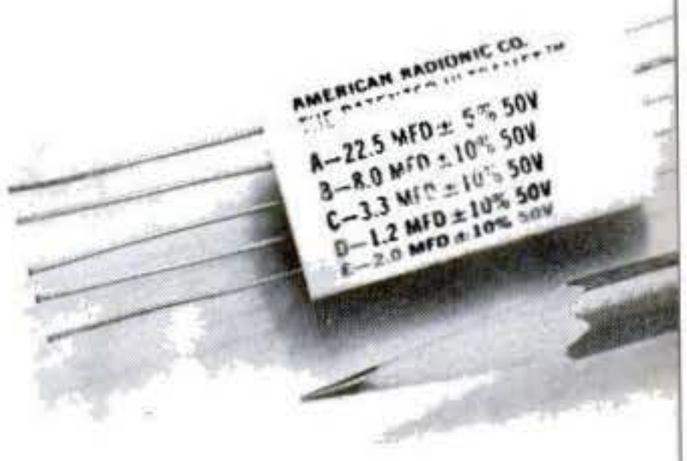
Want to keep your private conversations private? Screw Phone-Guard over your telephone's mouthpiece and if its red light comes on, you know someone is eavesdropping on an extension phone. It's $49.95 from Cose Technology Corp., 15 E. 40th St., New York, N.Y. 10016.

Wire/pipe finder

Move the MD-12 detector across your wall and it will tell you where hidden pipes, nails, or electrical lines are located—no test holes or guesses to make. It has adjustable sensitivity. Price: $16.95 from Lamb Ind., Box 25110, Portland, Ore. 97225.

Many-in-one caps

Design a circuit board and discrete capacitors take up much of the room—now there's a better way. Ultramet, from American Radionic (51 Austin St., Danbury, Conn. 06810), can replace two or more metalized film caps in one package.



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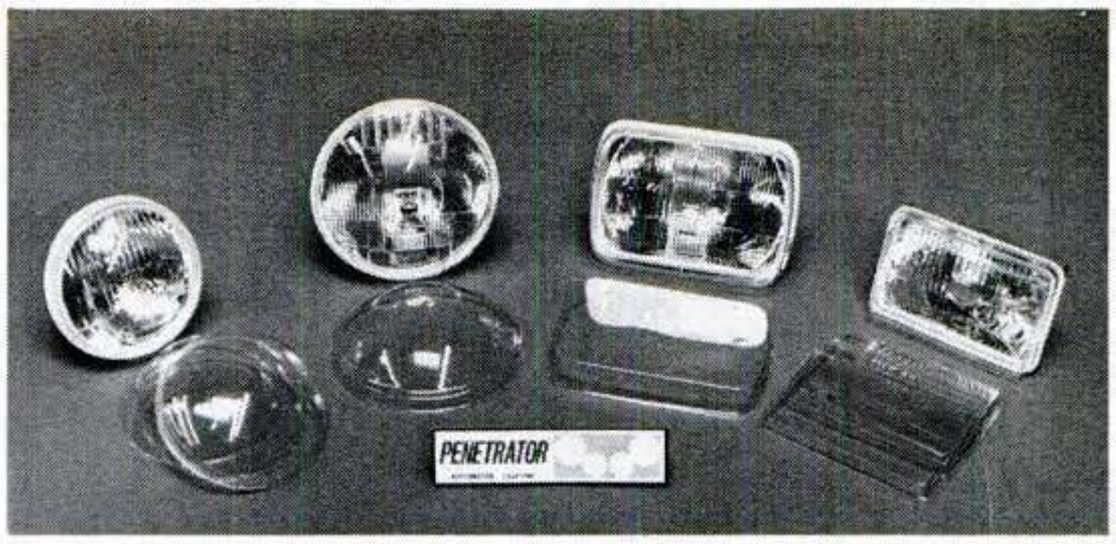
What's New
FOR YOUR CAR

BY ED JACOBS



Headlight covers

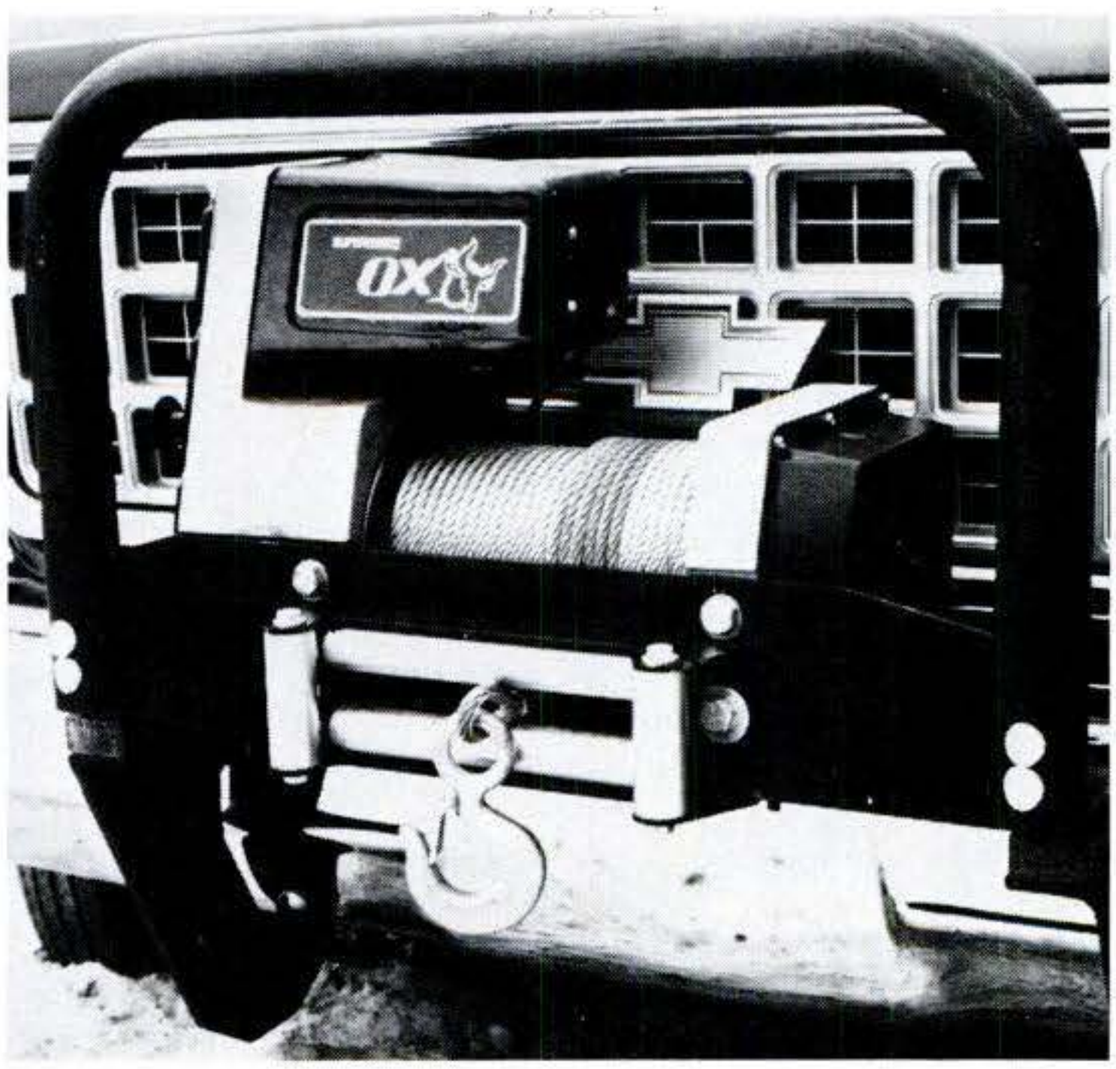
Penetrator clear polycarbonate-resin covers protect your car's headlamps from flying stones and other debris. They're guaranteed unbreakable, and cost from $6.50 to $8.50 per set. F&W Rally Engineering, 39W960 Midan Dr., Elburn, Ill. 60119.

Slide/flip-up top

The back of Tel-Top III telescopes into the front, giving access to the rear of your pickup for tall or bulky cargo. It costs $869.95, fits all domestic eight-foot pickup beds. Top-Line Products, Inc., N. Paul & E. 5th St., Owen, Wis. 54460.

Heavy-duty winch

A combination of chain-and-sprocket and cycloidal gear drive gives the Superwinch OX-201 a 202.5:1 reduction ratio—and faster cable speeds. It comes with 150 ft. of cable, is lubricated for life, and costs $679.95. Superwinch, Inc., Rte. 52, Putnam, Conn. 06260.



Versatile computer

The Zemco computer can be installed on any non-fuel-injection vehicle. It has 28 functions, including instant mpg, speed, time, and distance, and computes in English and metric units. Price: $120. Zemco, Inc., 12907 Alcosta Blvd., San Ramon, Calif. 94583.

High-flow muffler

Maremount's Turbo-Flow low-restriction, high-flow muffler is claimed to reduce exhaust back pressure so your engine works easier and more efficiently. A limited lifetime warranty includes do-it-yourself installations. Price: $44.95.

Power converter

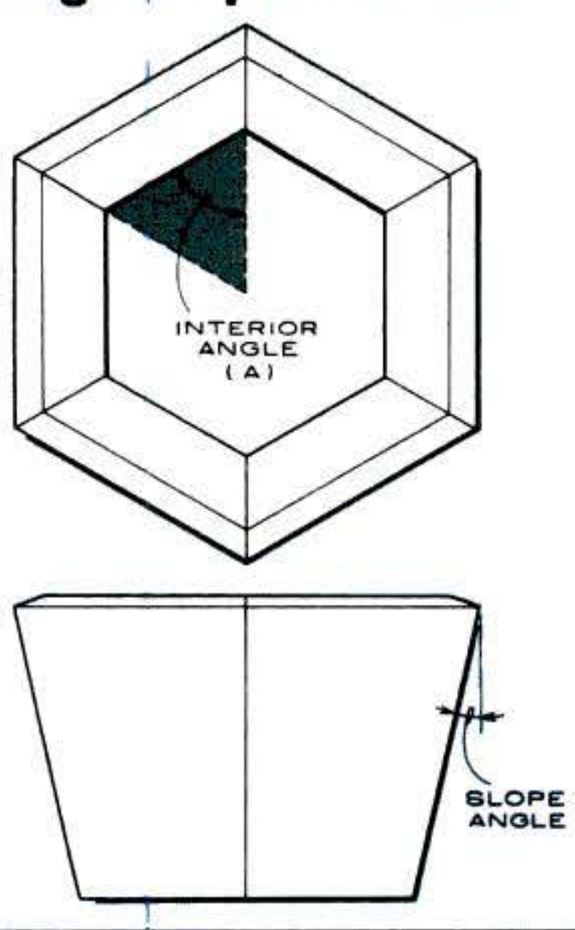
Universal Auto Adapter DC690-5 can run six- or nine-volt devices from your vehicle's 12-volt cigarette lighter. It's $12.95 with five power-adapter plugs, from Dynamic Instrument Corp., 933 L.I. Motor Pkwy., Hauppauge, N.Y. 11787.

How to calculate saw angles for **compound miters**

Plug two values into these formulas and solve them for angle settings

By R. JOSEPH RANSIL

Hexagonal planter box



Recently I helped my son figure out how to calculate the cutting angles to make a planter with tapered sides. Deriving the two formulas was tough, but you'll find *using* them (with a calculator equipped for trig functions) makes it easy to calculate saw angles for cutting the sides of any structure with identical, sloping sides—picture frames, for example.

Don't let the mention of trigonometry scare you off. You don't have to be a whiz at trig to use this method. And you don't need a fancy, expensive calculator. Any low-cost model with preprogrammed trig functions (including inverse or arc functions) will do the job. A table with selected settings is provided here for those who don't have access to a suitable calculator.

To calculate saw-angle settings, you have to know the number of sides and the slope angle between any side and the vertical of the structure you're building. The number of sides determines the value of an interior angle—called angle A in the hexagonal planter illustrated. This value will be needed in the formulas that follow.

The exterior-angle figures below give angle-A values for regular structures with three to 15 sides. You can confirm these values using this formula:

$$\text{angle A} = 90° - \frac{180°}{\text{no. of sides}}$$

Practical slope

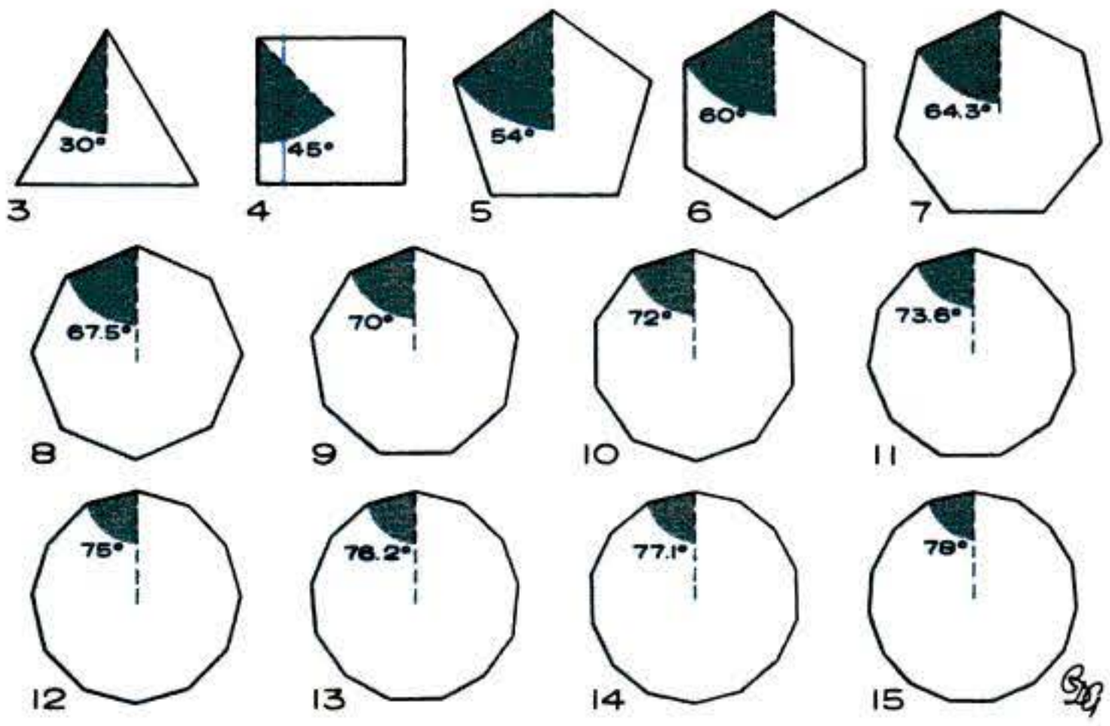
The slope angle may be anything between zero and 90 degrees, but the practical range is from about five to 70 degrees. Once you know the slope angle and angle A, you can calculate the arm angle and blade-tilt angle for your radial-arm saw, or the miter and tilt angles for your table saw.

Here are the two formulas used to calculate saw angles (the abbreviated forms of trig functions, such as tan for tangent, are used):

$$\tan(\text{arm angle}) = \cot(A) \times \sin(\text{slope}), \text{ and}$$
$$\sin(\text{tilt angle}) = \cos(A) \times \cos(\text{slope})$$

The first equation shows that the tangent of the arm angle is equal to the cotangent of angle A times the sine of the slope angle. (Most calcula-

Interior angle (A) vs. number of sides



Selected saw-angle settings

	3 sides		4 sides		5 sides		6 sides		8 sides	
Slope angle	Tilt angle	Arm angle	Tilt angle	Arm angle	Tilt angle	Arm angle	Tilt angle	Arm angle	Tilt angle	Arm angle
5	59.6	8.6	44.8	5.0	35.8	3.6	29.9	2.9	22.4	2.1
10	58.5	16.7	44.1	9.9	35.4	7.2	29.5	5.7	22.1	4.1
15	56.8	24.1	43.1	14.5	34.6	10.7	28.9	8.5	21.7	6.1
20	54.5	30.6	41.6	18.9	33.5	14.0	28.0	11.2	21.1	8.1
25	51.7	36.2	39.9	22.9	32.2	17.1	26.9	13.7	20.3	9.9
30	48.6	40.9	37.8	26.6	30.6	20.0	25.7	16.1	19.4	11.7
35	45.2	44.8	35.4	29.8	28.8	22.6	24.2	18.3	18.3	13.4
40	41.6	48.1	32.8	32.7	26.8	25.0	22.5	20.4	17.1	14.9
45	37.8	50.8	30.0	35.3	24.6	27.2	20.7	22.2	15.7	16.3
50	33.8	53.0	27.0	37.5	22.2	29.1	18.8	23.9	14.2	17.6
55	29.8	54.8	23.9	39.3	19.7	30.8	16.7	25.3	12.7	18.7
60	25.7	56.3	20.7	40.9	17.1	32.2	14.5	26.6	11.0	19.7
65	21.5	57.5	17.4	42.2	14.4	33.4	12.2	27.6	9.3	20.6
70	17.2	58.4	14.0	43.2	11.6	34.3	9.9	28.5	7.5	21.3

Notes: All angles in degrees. Slope angle measured from the vertical. For table saw, substitute miter angle for arm angle.

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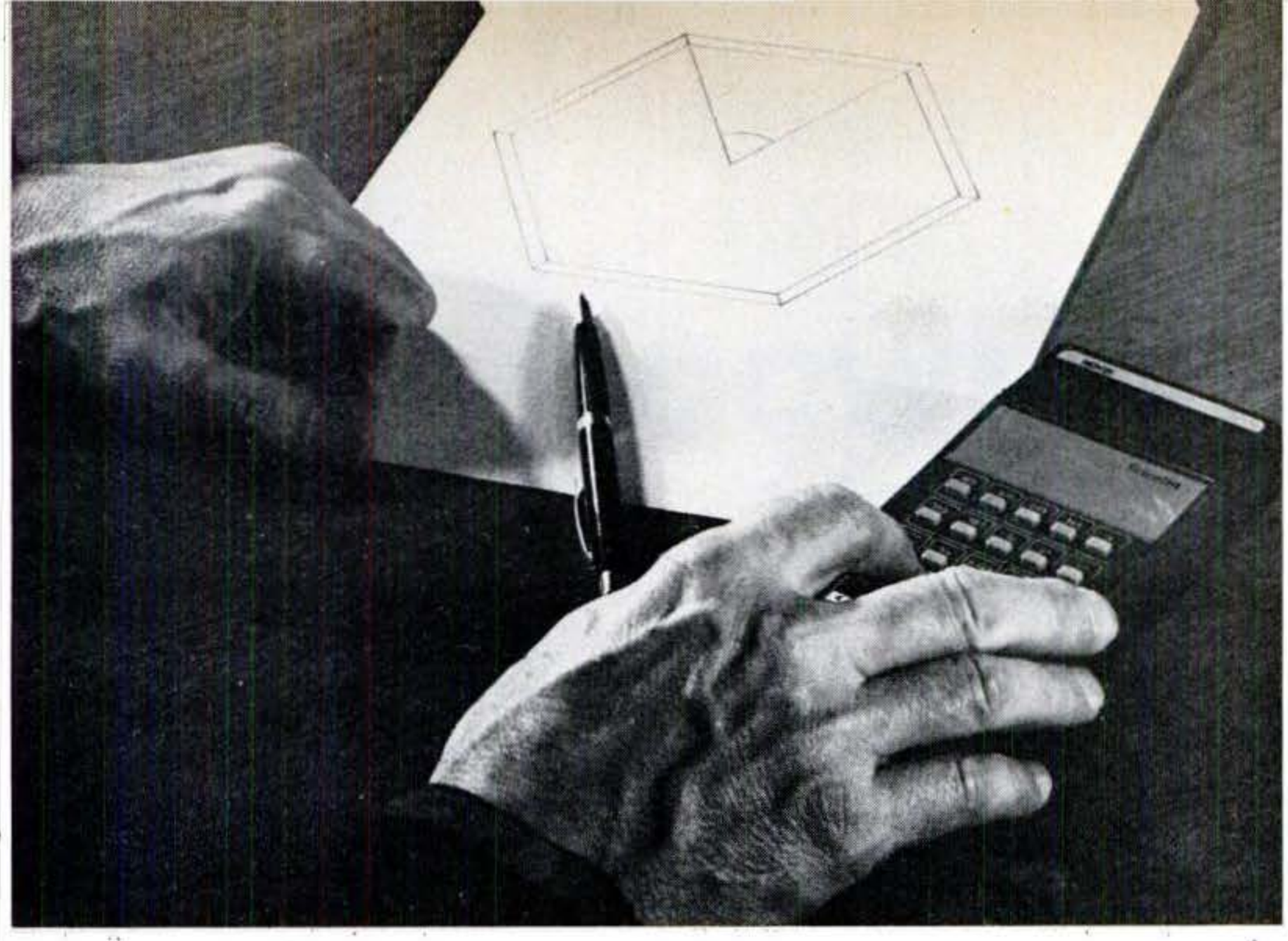


tors don't have a direct cotangent function, so you'll use the 1/x function on your calculator to find the reciprocal of the tangent, which is the cotangent.) The second equation says the sine of the blade-tilt angle is equal to the cosine of angle A times the cosine of the slope angle.

To calculate the saw angles, you simply plug the values of angle A and the slope angle into the right side of these equations, and solve for the arm angle and blade-tilt angle. The calculator makes this very easy. Note that if you're using a table saw, you simply substitute the miter angle for the radial-arm saw's arm angle. The blade-tilt angle is the same in either case.

Before we try a sample calculation, a word is necessary about the differences in calculator models. Some use the algebraic entry system, in which operation keys (×, −, +, etc.) are generally used just as they're encountered in equations. Other models, such as the Novus 4520 I used, have an entry system in which the operation key is used last. Another difference between calculator types involves the key for arc or inverse functions: Mine has an ARC key; yours may have an INV key. Both do the same thing. In the following example, the keystrokes given are those for my model, but the sequence should be easy to translate into one your calculator understands.

Now let's try a design example—the hexagonal planter box—to demonstrate the ease of calculation. From the chart, you find that angle A is 60 degrees for a six-sided structure. Next, let's choose 10 degrees for the side slope. Plugging these numbers into the two formulas, we get:

tan(arm angle) = cot 60° × sin 10°, and
sin(blade-tilt angle) = cos 60° × cos 10°

The keystroke sequence for the arm angle is:

Key step	Result
Press *6*, then *0*	Enters 60 (angle A)
Press *tan*	Calculates tan 60°
Press *1/x*	Converts tan A to cot A
Press *1*, then *0*	Enters 10 (slope angle)
Press *sin*	Calculates sin 10°
Press ×	Multiplies prior results
Press *ARC*, then *tan*	Calculates arm angle (5.7° in this example)

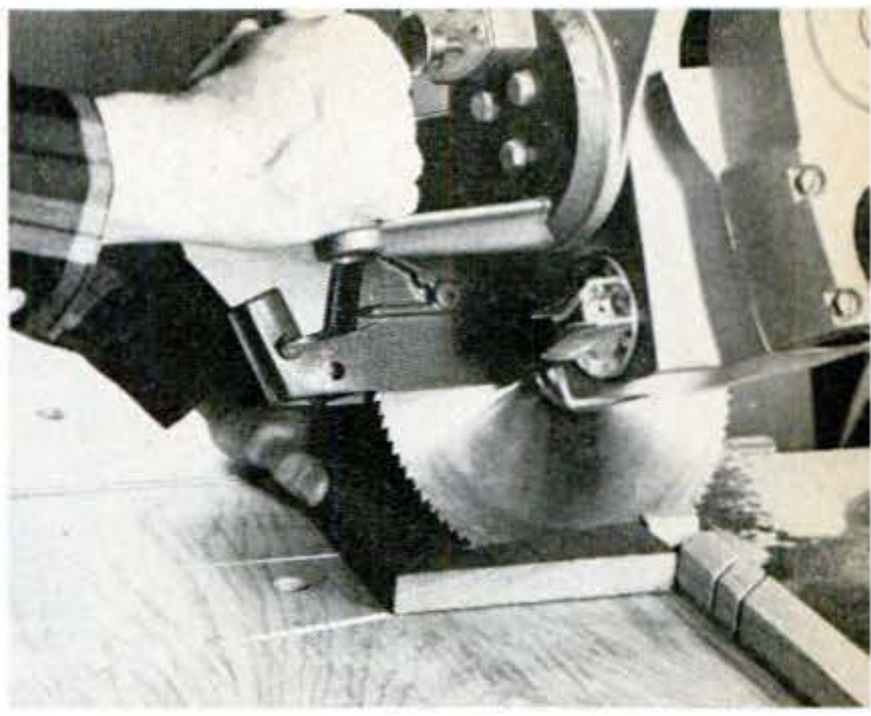
For the blade-tilt angle, the sequence is:

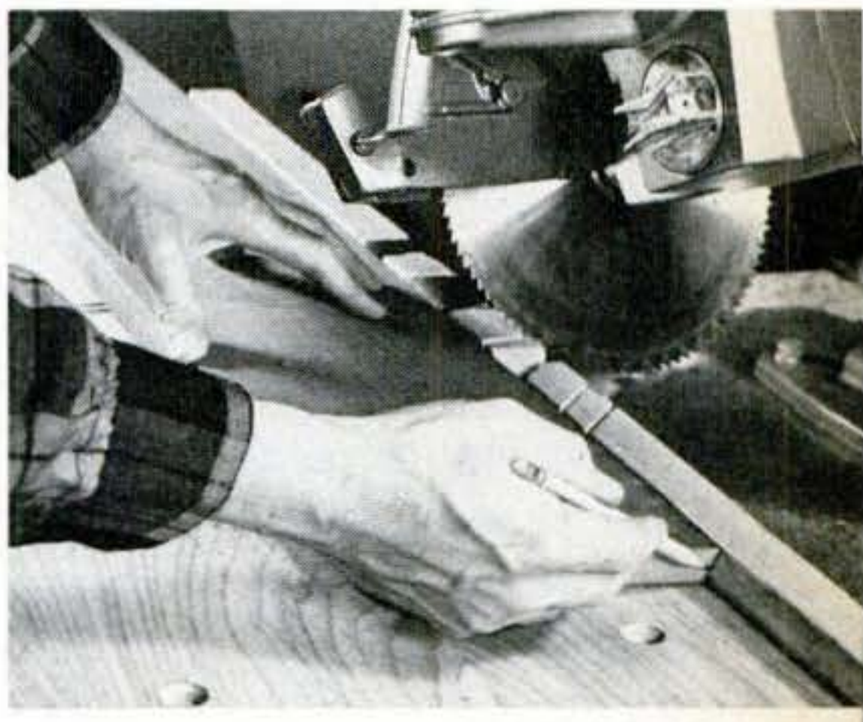
Key step	Result
Press *6*, then *0*	Enters 60 (angle A)
Press *cos*	Calculates cos 60°
Press *1*, then *0*	Enters 10 (slope angle)
Press *cos*	Calculates cos 10°
Press ×	Multiplies prior results
Press *ARC*, then *sin*	Calculates tilt angle (29.5° in this example)

To cut the first edge, set the arm 5.7 degrees to the right, and tilt the blade 29.5 degrees (down to the right) as shown in the series of photos. You won't be able to set tenth-of-a-degree angles, but set your saw angles as accurately as possible: Errors tend to be multiplied by the number of cuts you make. As a general rule, it is better to err on the side of larger angles, because then any gaps will show up on the inside of the piece.

Use a blade that provides a good finish cut, such as a hollow-ground combination or a crosscut blade. It is also important to cut all sides exactly the same width; the photo sequence illustrates how.

The large table provides saw angles for 14 slope angles and five types of structures for those without calculators. But for that custom-designed planter box, hopper, or pyramid, a calculator and the formulas presented can give you the exact angles you want. PS





Set and check angle settings, then make first cut (top). Flip board over, measure desired width, and mark rail (center) or set stop to assure equal widths for all cuts. Continue flipping board and aligning it on mark (bottom) till all sides are cut.

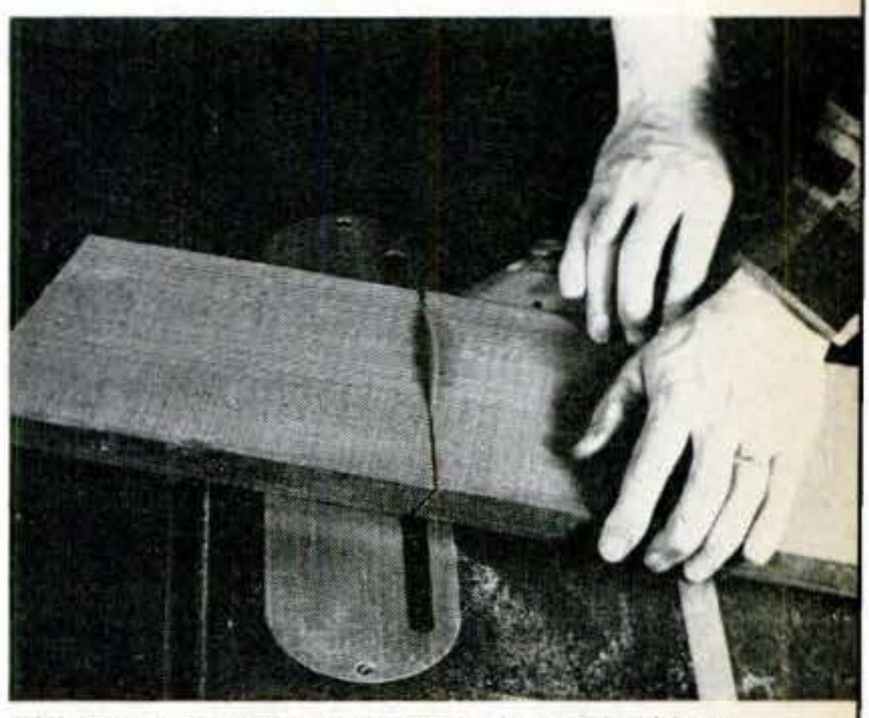


Table-saw cuts are similar. Use masking-tape marker or gauge block to assure uniform size. Press board against miter.

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Redwood deck screens an above-ground pool

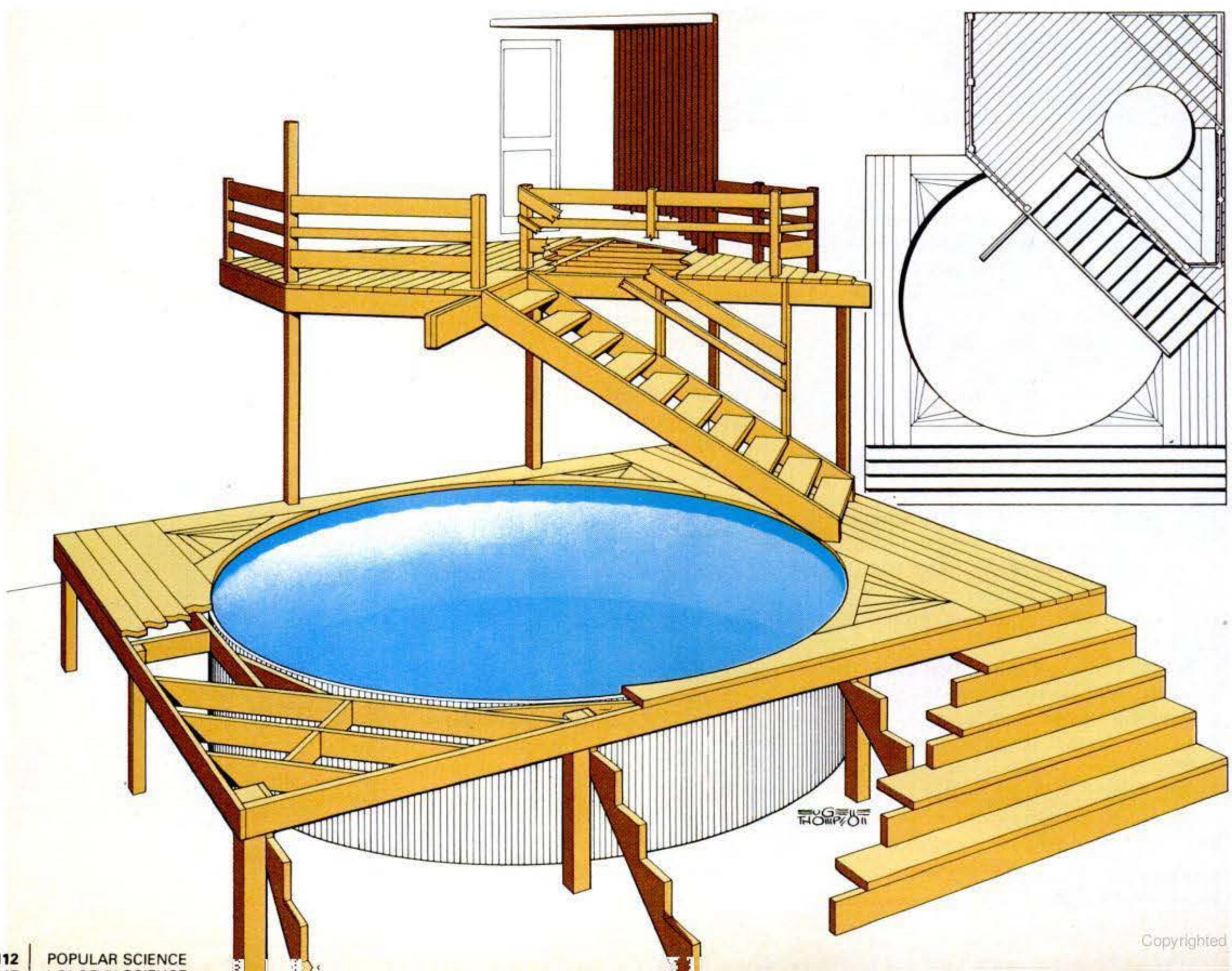
A multi-level redwood deck turns a backyard eyesore into a handsome asset

By RICHARD STEPLER
DESIGN BY JAN ENGBERG
PHOTOS BY MARIANNE ENGBERG

The setting of this dramatic deck is a city backyard, but screening an unsightly above-ground pool is equally desirable in the suburbs or the country. Not only do you mask the pool's ungainly (and awkward) sides (they're four feet high in our backyard example), but you get the bonus of easier access and a sunning space.

Brooklyn brownstoner Jan Engberg designed this deck to provide a multi-level transition from his row house to backyard in three easy steps:

- Top level, with a sun and privacy screen, provides an outdoor dining space for the kitchen just inside.
- A flight of stairs (they're actually cantilevered over the pool) descends to



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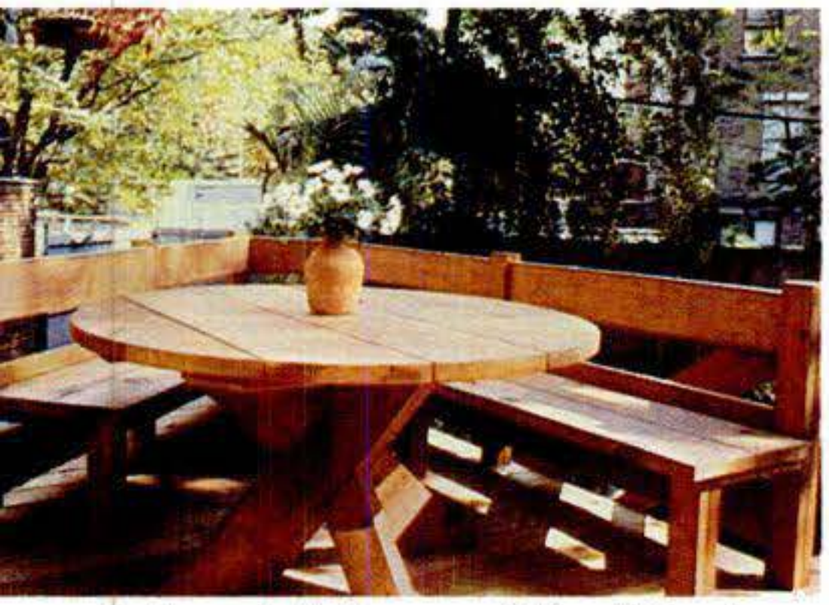
the swimming-sunning area. The redwood decking is neatly trimmed around the pool's lip.

- Finally, a broad, full-width-of-deck set of steps gives access to the backyard.

Engberg chose construction-heart-grade California redwood for his deck. This grade is recommended for any near-ground-level application exposed to weathering. Redwood is naturally resistant to insects and decay and is dimensionally stable as well—it resists warping, checking, and splitting. All these characteristics make the wood an especially suitable material for a pool surround, where it's likely to be subject to frequent inundations.

The only treatment needed for redwood (recommended by the California Redwood Assn.): application of a clear water repellent containing a mildewcide directly after completion, with repeated applications about every two years.

Deck construction is as shown in the drawing on the facing page. We don't give dimensions, since you'd have to size the deck for your pool and its site. For deck-construction techniques, see "Two Backyard Decks Built to Last" in last month's issue. PS



Redwood deck spans full width of row house's backyard (top photo). Bird's-eye view (right) shows dining nook on top level (also see above), plus a sunny spot for a hammock. Stairway to lower level has railing on one side only, doubles as a stepped high dive for the daring. Photo (above, top) shows unusual framing needed to skirt 15-ft. dia. pool.

DC welding — it's easy with new combo rigs

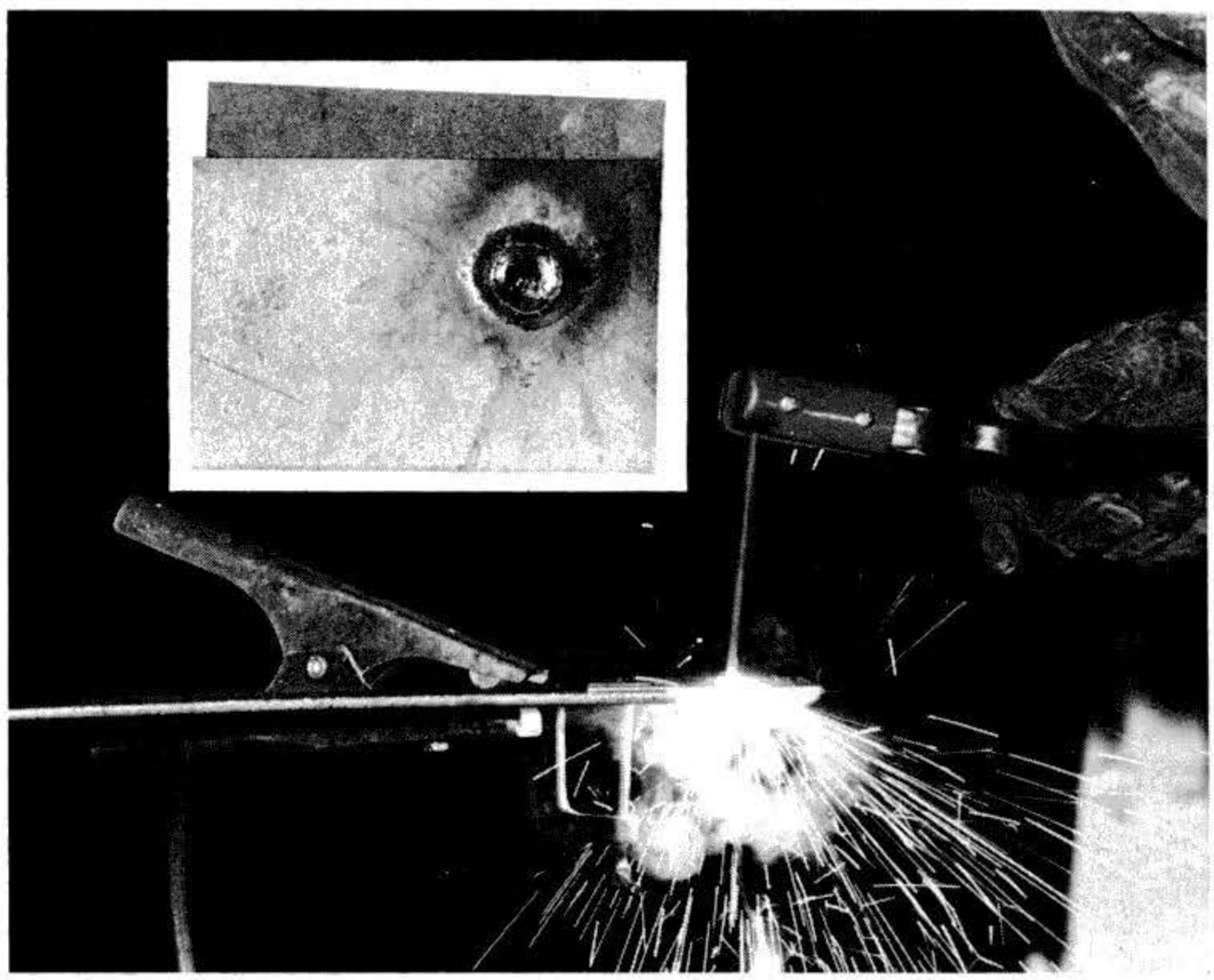
Now you can make those tricky welds you couldn't with sputter-box units

By E. F. LINDSLEY

Like most owners of ordinary AC sputter-box transformer welders, I like the convenience mine offers—but I'm sometimes frustrated by its limitations. I would like to be able to cut steel cleanly, pierce neat holes, weld light auto-body steel, spot-braze, make overhead and vertical welds, and stitch light metal together with spot welds.

None of these goes very well with AC welding. But all are possible—even easy—with a DC welder. The stumbling block: Until recently a DC rig was very expensive. Now, however, AC welders with DC taps are available at reasonable prices. Using Century's new 230-amp-AC/180-amp-DC transformer welder, I've just tried a series of those novel DC welding tricks. I'd never worked with a DC unit before, but they all worked well the first time.

Here's why a DC welder can do what an AC can't: An AC transformer welder reduces the voltage from your household input to welding-level voltage and raises the amperage. Thus, even though your house service may be limited to 100 amps, such a welder can deliver more than 200 amps at about 80 volts. This is fine for ordinary downhand welding on steel of more than 1/16 in. thickness and for carbon-arc brazing or heating. But with AC welding the heat distribution between rod and work metal can't be controlled, since the welder arc is alternating 120 times per second in phase with your house current. Consequently, it doesn't work very well for overhead welding or for the tricky welds I mentioned above.



Make a rivet weld in thin sheet metal by punching rod through arc-softened spot and slowly withdrawing. Back side (inset) shows button-like spot. Using 7014 iron-powder rod, 50–100 amps DC, and reverse polarity, action is fast with little distortion.

With the DC feature, that's all changed. You simply plug into a different set of outlets and draw rectified current instead of AC. Now you can work with straight polarity (electrode negative and work positive) or reverse polarity (electrode positive and work negative). Straight polarity puts 70 percent of the heat into the work, 30 percent into the rod—great for deep penetration in flat welding, hard surfacing, flame-cutting, and gouging.

Reverse polarity puts 70 percent of the heat into the rod, and the molten metal hardens rapidly. That makes it easier to weld on overhead and vertical surfaces where you don't want the metal to run and drip. It also keeps excess heat out of the metal when rivet-welding, welding cast iron with nickel rod, welding light steel, or welding high-carbon or alloy steels with low-hydrogen rod. (Low-hydrogen electrodes such as 7018 are extremely important when welding modern equipment, including cycle frames and farm machinery built from high-carbon or alloy steel. The old general-purpose rods were fine for mild steel, but today's structures

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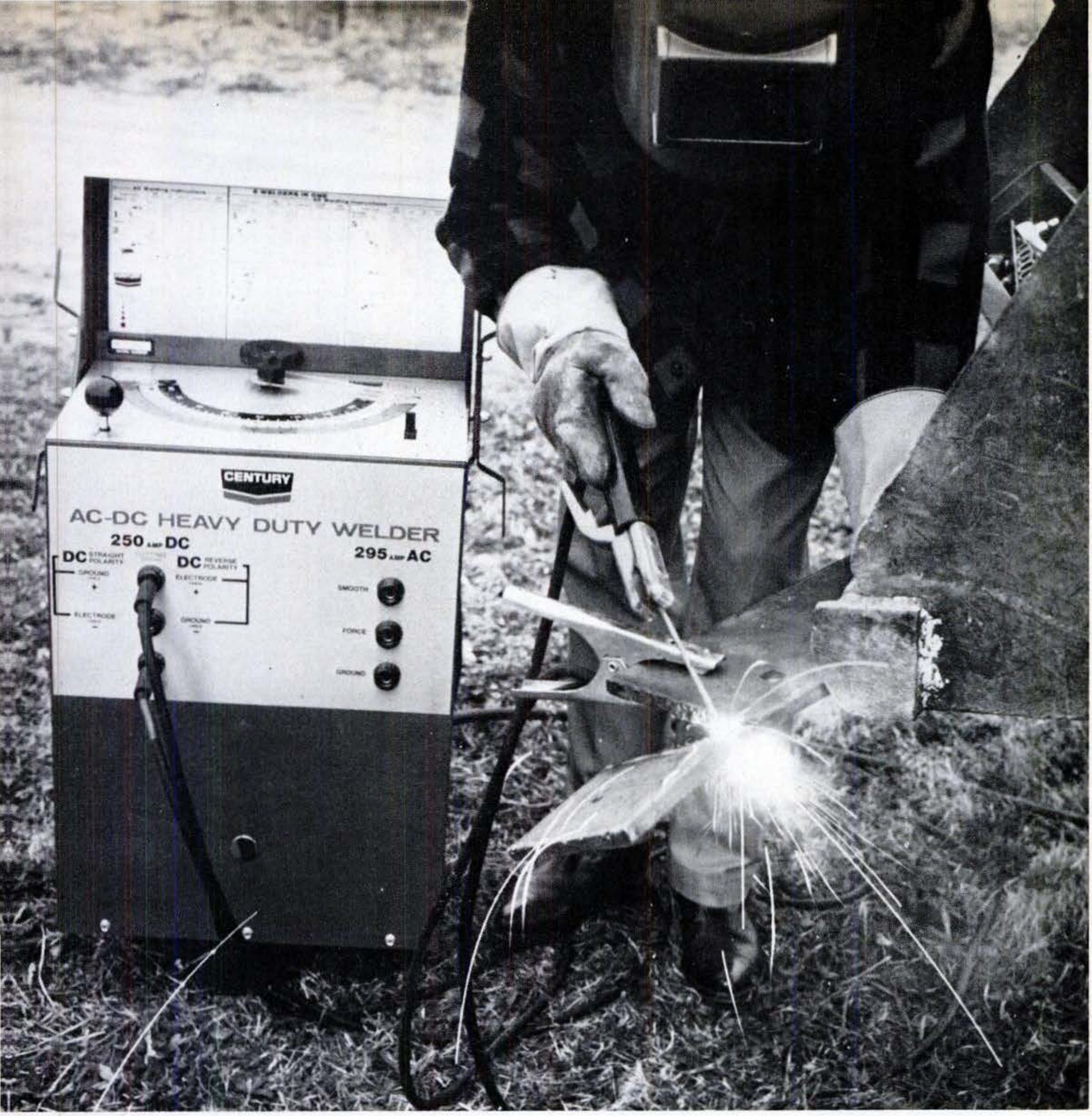

Heavy-duty AC/DC welder (above) and smaller unit tested by author (left), both from Century, bring a new world of possibilities to home welding. Welder above is making quick work of heavy cutting by using cutting tap on heavy-duty rig. Rod is held at 45-degree angle and moved up and down, much like a hacksaw. At left, author welds thin spacer to axle with 35 amps DC, 7014 rod, and reverse polarity. Arc is soft, readily struck, doesn't tend to burn light metal. It's great for auto-body repair.

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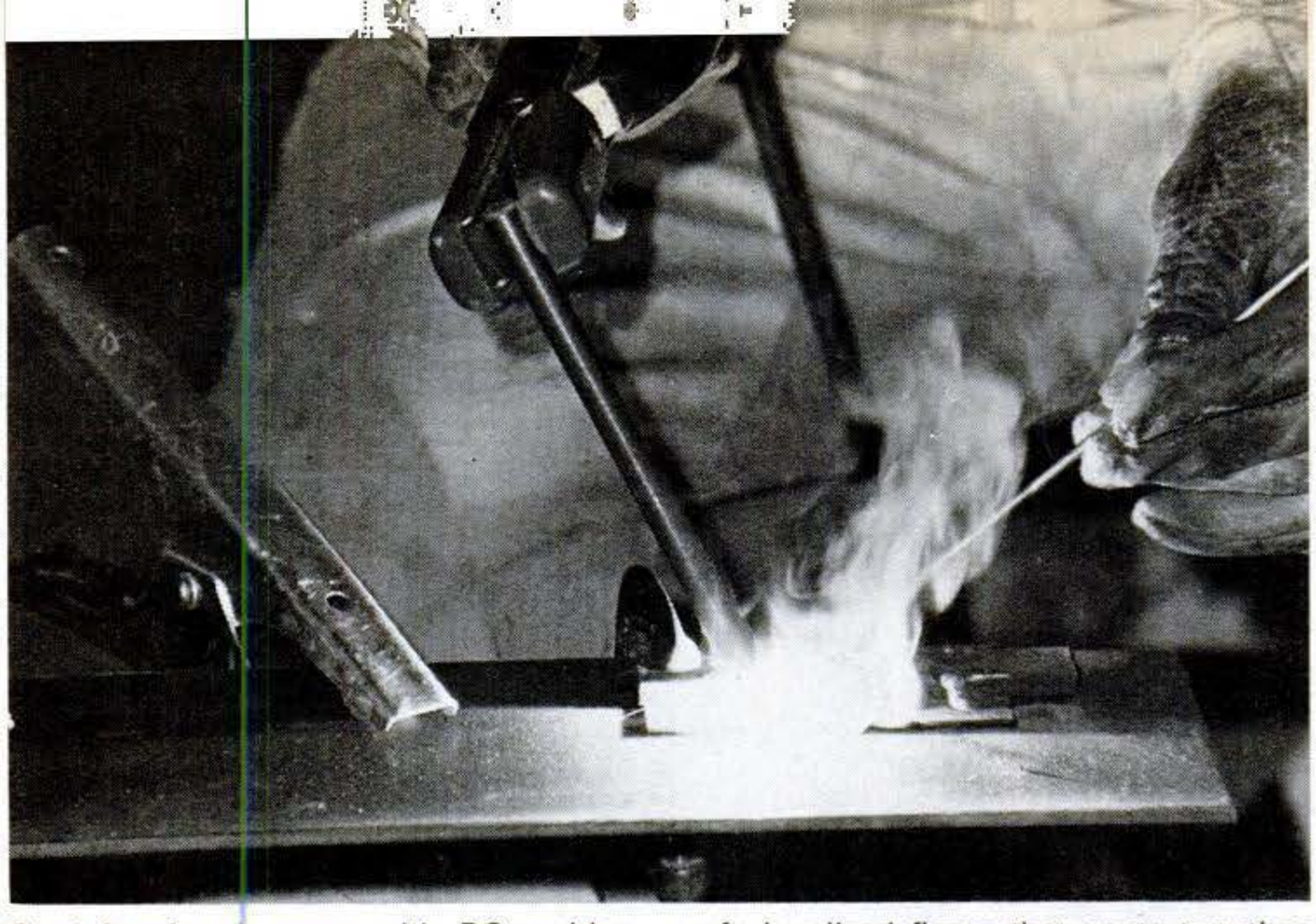
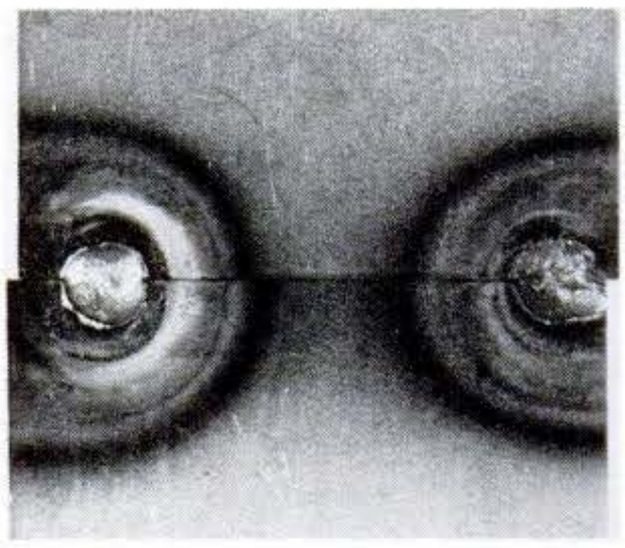
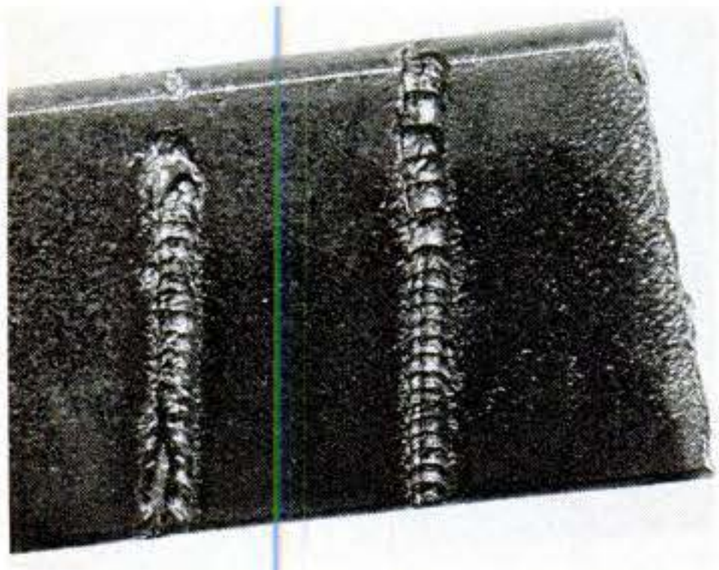


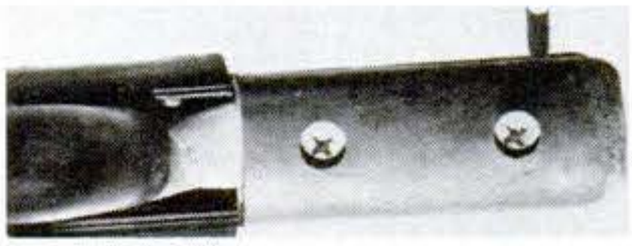


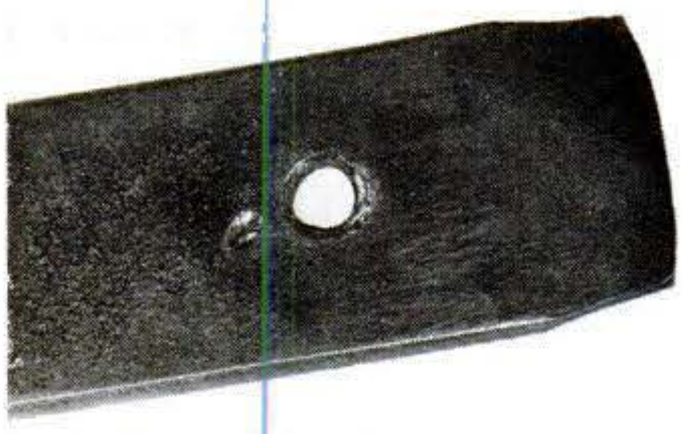
Spot brazing is easy with DC welder. Straight polarity with a single 5/16 carbon rod in holder at 60 to 100 amps gives a soft, localized flame that spots together thin sheet metal (above right), or locks thick piece to thin (top right). Even bad fits with gaps are easily bridged. The trick is to place rod where you want it and strike carbon on rod to establish arc.



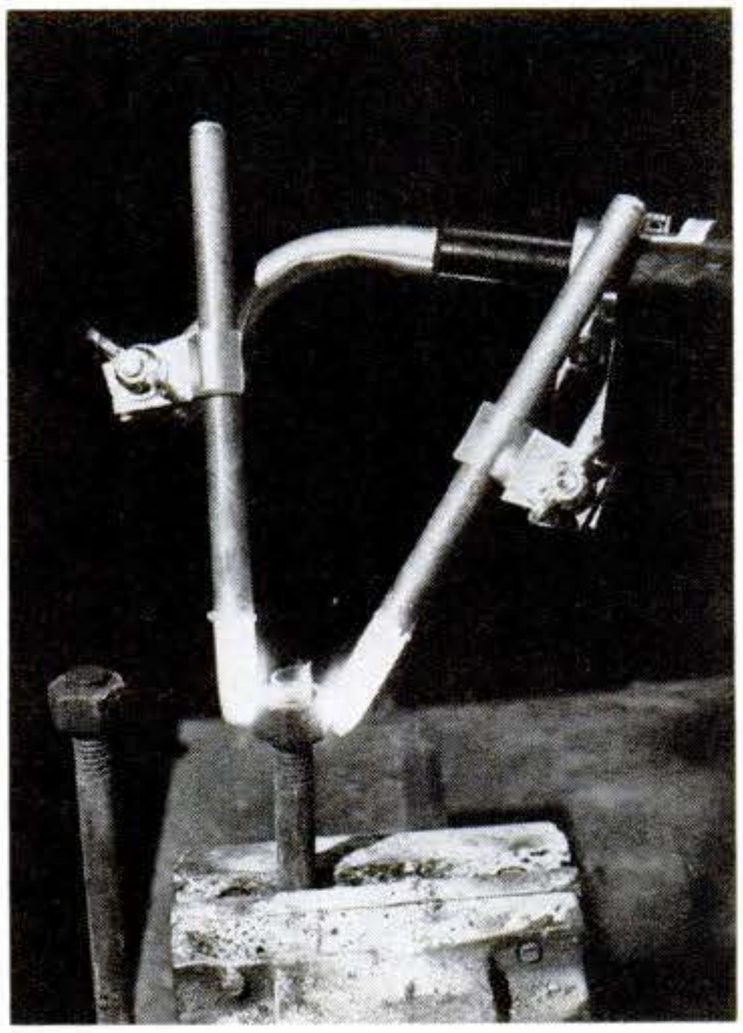
Old car spring was cut off using straight polarity, full amperage, and 6011 rod. Gouges were just for practice, but by holding rod almost flat on work you can gouge out cracks for repair welding that otherwise would take lengthy grinding—if you could get grinder to location.

Vertical welding is easy with DC reverse polarity and 6011 rod held at about 30-degree angle. Trick is to drag rod with outer coating actually touching work.





To put hole in hard steel—when a drill won't cut it or for holes too large for twist drills—use straight polarity, high amperage, and 6011 rod.



Frozen nuts, even pipe fittings, yield to carbon torch, using (in this case) AC at 100 amps. Although carbons are glowing, there's no flame; procedure is fairly safe even under car or in confined spot. Nuts are usually undamaged. Loosening results from expansion.

can't be welded properly with them.)

Since welding light sheet metal has, in my experience, always been a nightmare of burned-through holes and lumpy, useless beads, I first tried the new welder on some 1/16-inch sheet metal. On reverse polarity at 30 amps I used a 7014 iron-powder rod and struck an arc with ease. The flame was very soft and didn't burn through.

From there I went on to spot-welding, single-carbon brazing, cutting and punching holes, and flame-gouging. The nicest trick was single-carbon brazing. Ordinarily, with two carbons in a carbon-arc torch, the flame tends to overheat and distort light metal, especially if you're brazing a heavier piece to it. With a single, pencil-point DC carbon rod in the electrode holder, you place the brazing rod in contact with the metal, touch the carbon to the brazing rod, and presto, you have instant heat that lets you lead the molten metal to the exact spot you want or even across gaps.

I wasn't optimistic about gouging, cutting, and punching holes with an arc. But with straight polarity DC, full amperage, and 6011 rod, I found that tough spring steel and heavy angle iron can be slashed through like butter. The same was true for punching holes in metal that would turn an ordinary drill blue and blunt.

Century says that its heavy-duty 295-amp-AC/250-amp-DC welder is a bit better for these jobs because of more precise current control, but even the smaller unit I tested opened my eyes to the advantages of the combination AC/DC-type welder. The smaller rig lists for $359.50; the heavy-duty outfit is $699.50. Century Mfg. Co., 9231 Penn Ave. South, Minneapolis, Minn. 55431. PS

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You can do your own alternator servicing

By RAY HILL

A malfunctioning alternator is expensive to have repaired. But you can do the job yourself and save most of the cost.

For example, a common alternator problem is worn-out brushes. "If that's all that's wrong with your alternator," says Steve Mercaldo, professional mechanic and PS consultant, "chances are a garage is still going to charge you for a rebuilt alternator, since most alternators must be disassembled to replace a brush set."

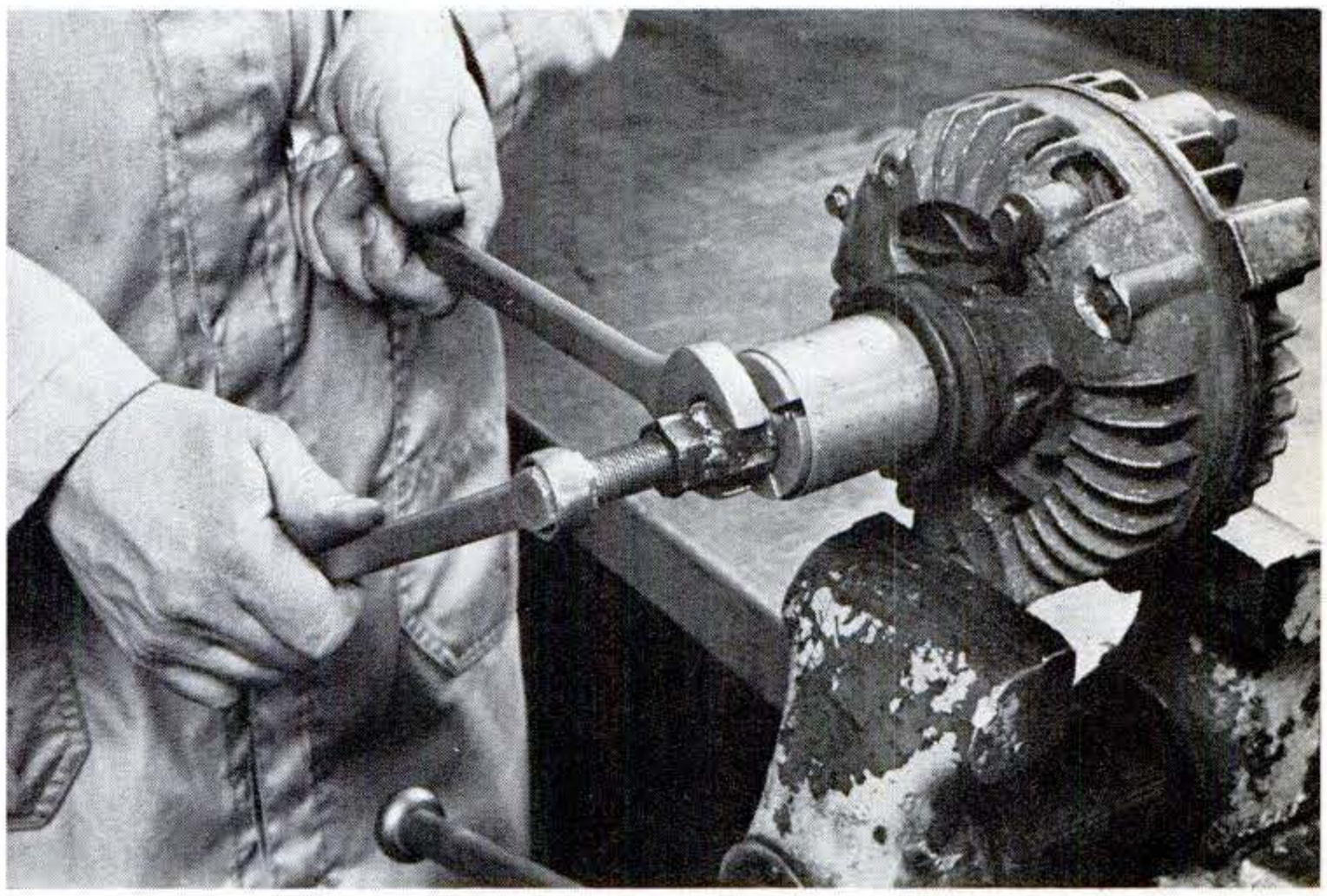
The difference in cost? Where I live, for instance, I'd have to pay $55–$75 for a rebuilt alternator for my car. A pair of brushes costs about two dollars.

With an ohmmeter and your car's shop manual, you can check out your alternator and repair it yourself. If you don't have an ohmmeter, you can use a battery-powered 12-volt test lamp. You can also use a 110-volt test lamp on all the alternator's electrical components, except for the diodes. For these you must use either an ohmmeter or a 12-volt test lamp. A 110-volt lamp will ruin them.

All alternators work basically the same way (see drawings). But the specifics of disassembly and checking of components can vary among makes. That's why you need a shop manual for your particular car.

When an alternator, or its voltage regulator, gets sick, usually one of four things happens: The battery doesn't charge, the battery only charges partially, the battery overcharges, or the alternator makes noise.

In the case of a no-charge or partial-charge problem, first make sure the alternator belt is tight. A slipping belt can result in reduced alternator output.



Chrysler alternators require a special puller to remove the pulley for disassembly. Do not try to pry the pulley off; you may damage the alternator.

If the belt is tight, check all wires and connections to the ignition switch, the alternator, and the regulator (unless the regulator is built into the alternator, as many are). Connections should be tight and uncorroded, and no wires should be broken or have insulation missing.

Good connections

Check and clean battery-cable terminal connections. Loose or corroded connections can result in an undercharged battery.

If belts, wires, and cables check out, make sure the battery is good. Fluid level should be at the bottom of the split ring at each fill hole. Charge the battery. When you're done, you want a hydrometer reading of 1.260 or better for each cell. If the battery won't accept a charge, replace it.

With the battery in the car, attach the plus voltmeter lead to the plus post of the battery and the minus lead to the minus post. With the coil wire disconnected at the distributor and grounded, crank the engine for 15 seconds, observing the voltmeter. The reading should not drop below 9.6 volts.

With a Delco Freedom battery or similar maintenance-free batteries, follow the maker's recommendations on charging and checking the battery's condition.

If the battery checks out, it's time to start investigating the charging system. Replace the coil wire in the distributor cap and leave the voltmeter connected across the battery posts.

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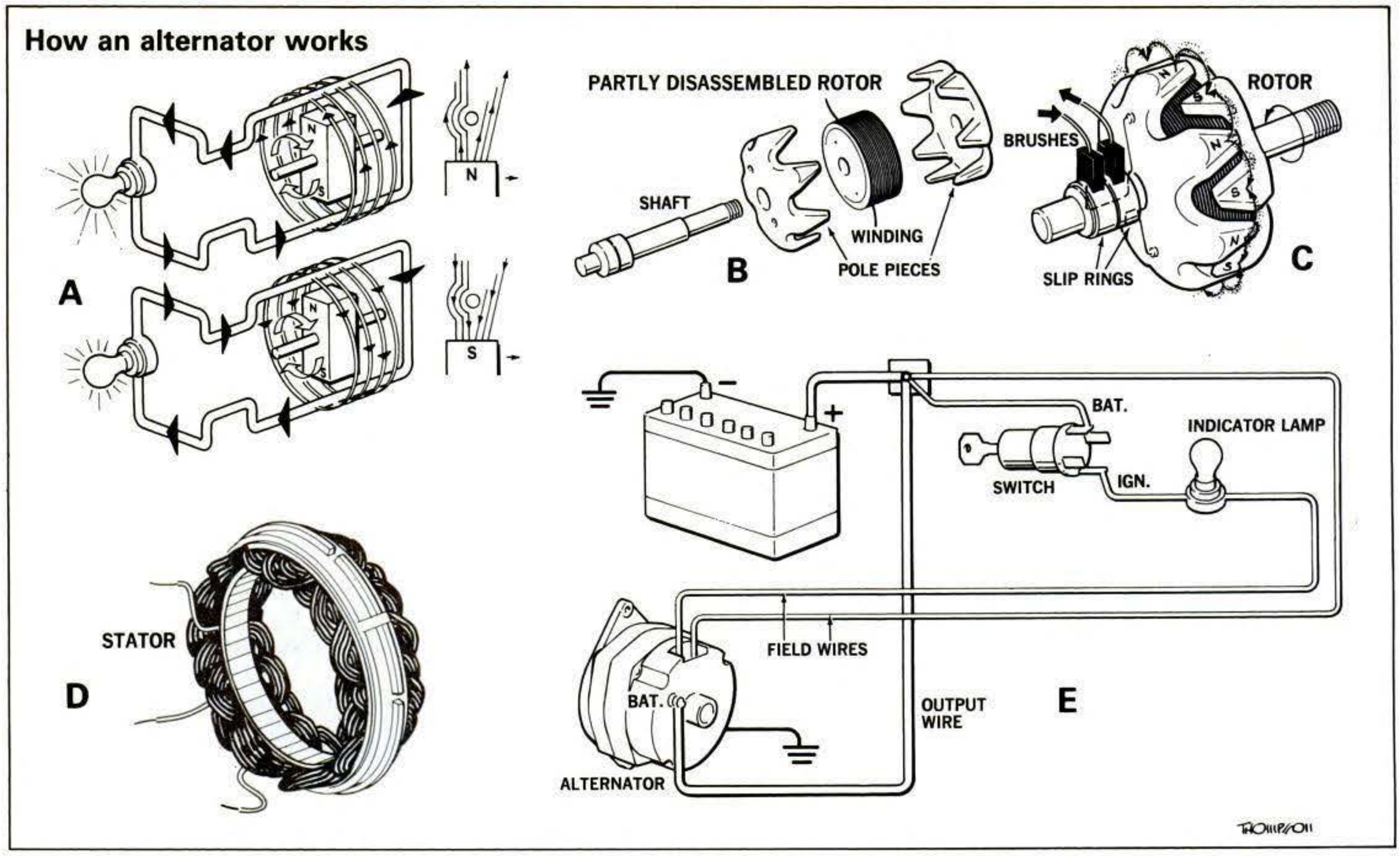
How an alternator works



This simplified alternator (A) consists of a stationary loop of wire and a rotating bar magnet. As the magnet rotates, its magnetic field slices through the loop of wire inducing alternating current. Applying this principle to an automobile alternator, the stationary wire loop is the stator and the rotating magnet is the rotor. In an automotive alternator, the rotor is an electromagnet made of many turns of fine wire (B). The ends of the wires are connected to slip rings on the rotor shaft. Spring-loaded brushes make continuous contact with the slip rings as the rotor turns.

At startup, battery current flows through the rotor windings (via the brushes and slip rings). A magnetic field is created around the rotor, which causes one of the pole pieces to become a north magnetic pole and the other to become a south pole. When the pointed ends are meshed (C), an alternating pattern of north and south poles appears around the circumference of the assembly. The rotor is encircled by the stator (D). As the rotor turns, its alternating north and south magnetic fields slice through the stator's many loops of wire.

The many loops of the stator are really made up of only three wires. As the rotor turns, an alternating current is produced in each wire. This results in a steadier flow of alternating current (three-phase AC), instead of a more pulsating current that would be produced if the stator consisted of loops from only one wire (single-phase AC). Six diodes (three negative and three positive) change the alternating current from the three stator wires into direct current, which flows out of the alternator's battery terminal.

To keep the alternator from producing too much current or a voltage that's too high, a voltage regulator controls alternator output by controlling the alternator's field current (which creates the rotor's magnetic field). When electrical demand increases (accessories turned on, partially discharged battery, etc.), the regulator lets more current flow through the rotor, increasing the strength of the rotor's magnetic field, and thereby producing more current in the stator. Drawing (E) shows basic charging-system circuitry for a GM system.

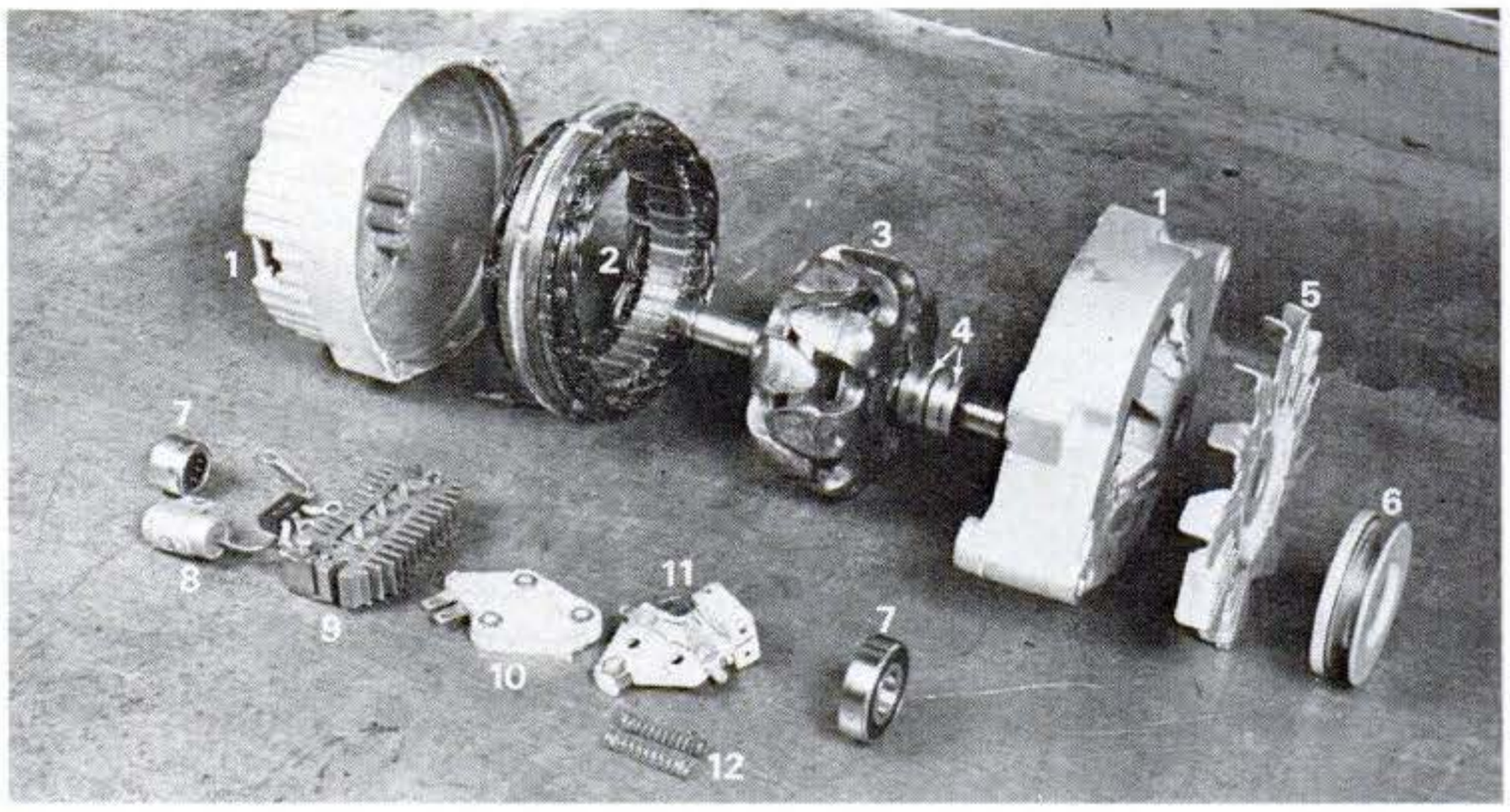
Alternators have been used on all American-made cars since the early '60's. Before that, generators—which produced direct current—were used.

Start the engine and run it at 2000 rpm. You should get a voltage reading between 13.5 and 15.3 volts (see shop manual for specs). If the reading is low, you've got a charging problem.

Isolating the problem

But is the problem with the alternator or the voltage regulator? To find out, full-field the alternator according to shop-manual instructions (also see PS, March, page 132). If you use a variable carbon pile, such as Sun's VAT 40, generally the amperage output should be within 10 percent of the alternator's rated output. If you don't have a VAT 40 or similar machine, output should be in the neighborhood of two-thirds of the alternator's rated capacity, or better.

If, when you full-field the alternator, the output doesn't change or is



Major parts of a GM alternator: (1) end frames, (2) stator, (3) rotor, (4) slip rings, (5) fan, (6) pulley, (7) bearings, (8) condenser (for radio interference), (9) rectifier bridge (contains six diodes for converting electrical flow from AC to DC), (10) voltage regulator, (11) brushes and brush holder, (12) brush springs (keep brushes pressing against rotor slip rings, permitting current to flow through rotor windings).

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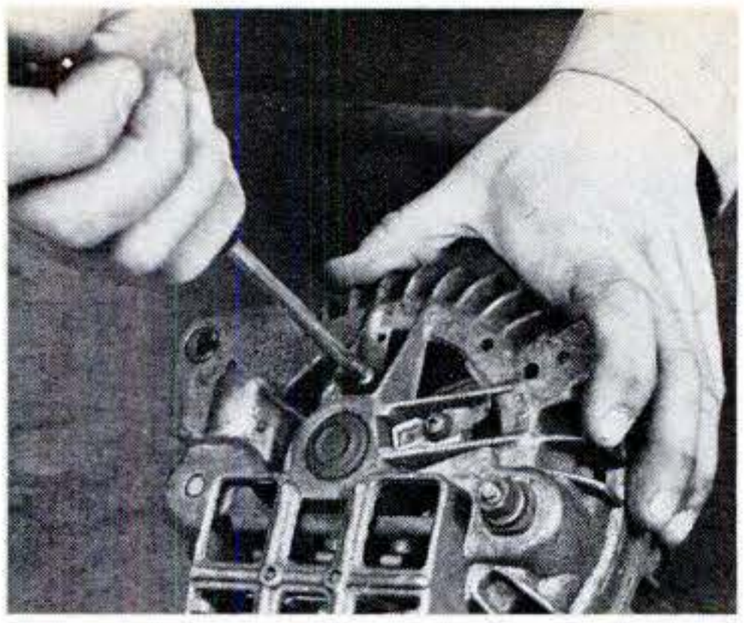
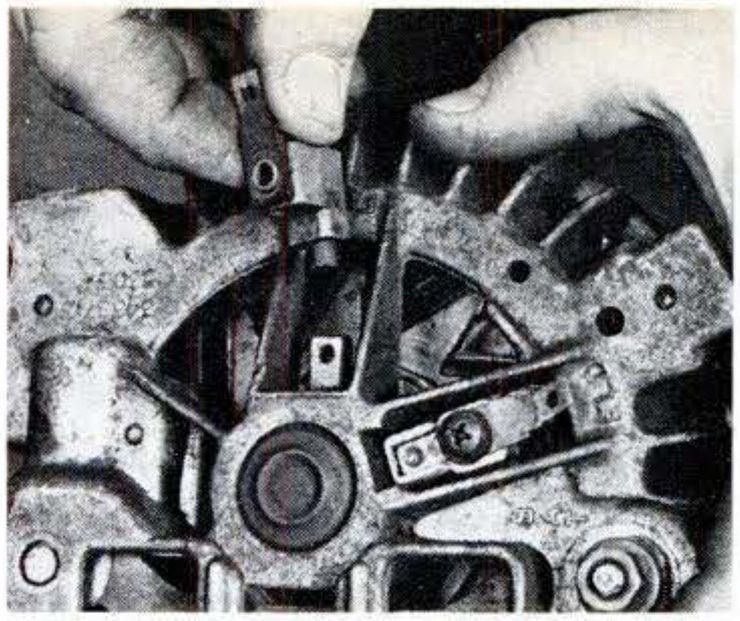




Brushes on Chrysler alternators can be checked without disassembling alternator. Just remove the screw, pull brush out, and inspect it. Other alternators require disassembly for inspection of the brushes. Follow shop-manual instructions.

well below what it should be, the alternator is probably faulty and should be checked out. If alternator output goes up to spec, the voltage regulator is probably bad.

Most voltage regulators nowadays are solid-state. A bad solid-state regulator cannot be repaired. It must be replaced. Some of them do have an adjusting screw, though. If yours is one of these, try adjusting the regulator in accordance with shop-manual specs. If that doesn't help, you should replace the regulator.

Some solid-state regulators are mounted inside the alternator. Others are not.

Some voltage regulators are electromechanical. Although this type can sometimes be adjusted and repaired, Mercaldo recommends replacing it if it goes bad.

If you must constantly add water to your car's battery, it's probably overcharging, "boiling" the water away. To check, hook a voltmeter across the battery terminals (plus voltmeter lead to plus terminal, minus lead to minus terminal), run the engine at 2000 rpm, and observe the voltmeter. Ordinarily you should get a reading between 13.5 and 15.3 volts. If you're getting a reading above spec and the battery and all connections check okay, replace the voltage regulator.

Alternator noise

Noise from an alternator may be caused by a variety of things. Check for a loose drive pulley or loose or missing mounting bolts.

A bad diode or stator can also cause noise. This sounds very similar to the noise made by a bad bearing. To determine quickly whether it's a diode-stator problem or a bad bearing, start the car and remove the alternator's field wire. If the noise stops, it's a diode-stator problem. If it continues, it's a bad bearing.

If the alternator must be disassembled, you'll have to take it off the car. First, disconnect the ground cable at the battery so you won't accidentally bridge any electrical connections while removing the wiring from the alternator (possibly causing alternator damage or burning your fingers).

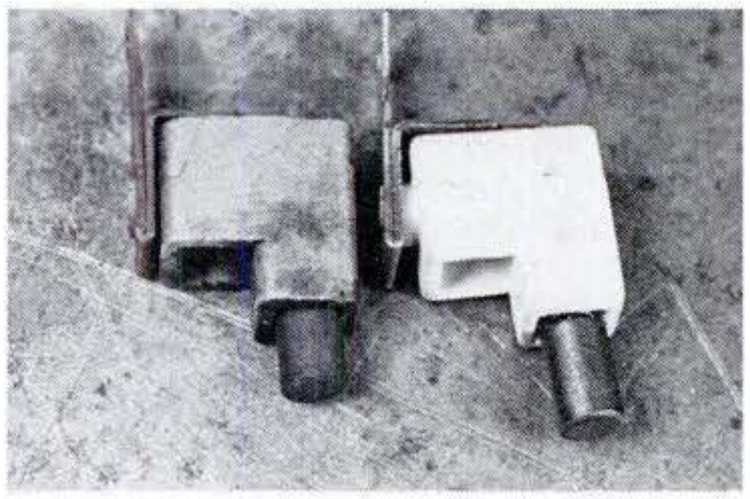
Remove the wires connected to the alternator. Label any that could be mixed up. The alternator will have three or four wires attached to it.

An easy way to label the wires is to wrap masking tape around each one and letter it "1," "2," "3," etc. Mark a corresponding number next to the wire's connection on the alternator.

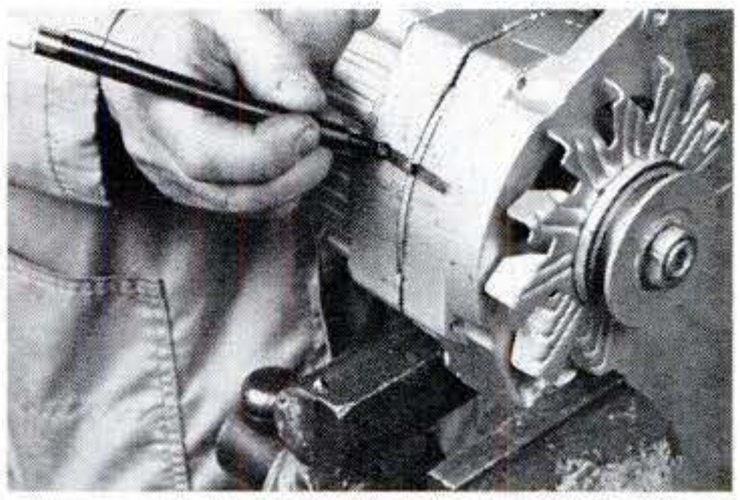
Remove the bolts that hold the alternator in place, and lift it out of the car.

When replacing the alternator, replace the alternator's pivot bolt and other attaching bolts, but leave them loose enough so that you can move the alternator to adjust the belt. Use a pry bar to pry against the alternator's frame so that the belt has a slight up-and-down movement between any two pulleys—but not more than a half inch. After the belt is adjusted, tighten the pivot nut and the attaching bolts and nuts. PS

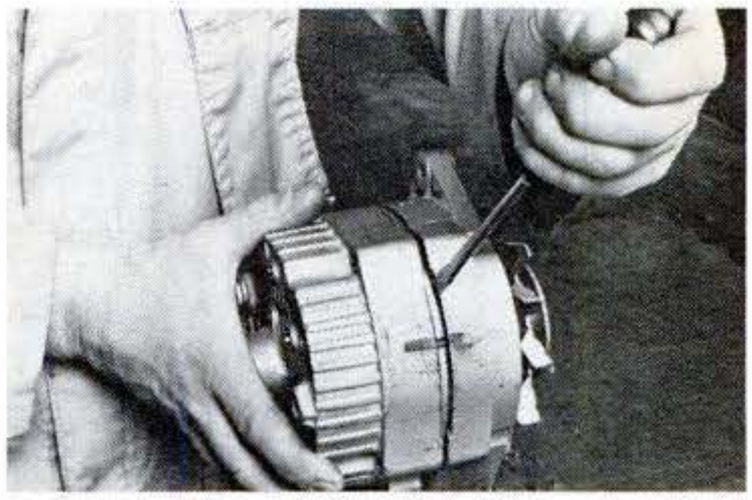
Turn page for more on alternators



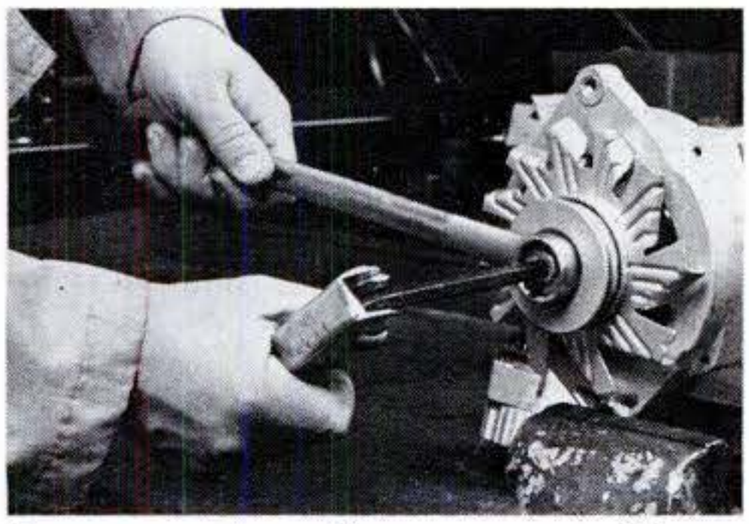
Used brush is shown at left, a new one next to it. Any brush should be at least ¼ inch long. New brushes are inexpensive and easy to install.



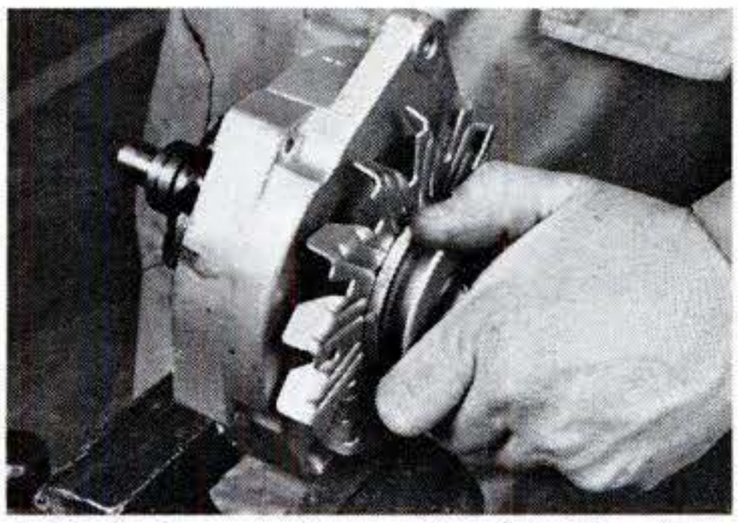
Mark alternator halves (end frames) with felt marker or scribe before disassembly. Then remove the bolts that hold the two end frames together.



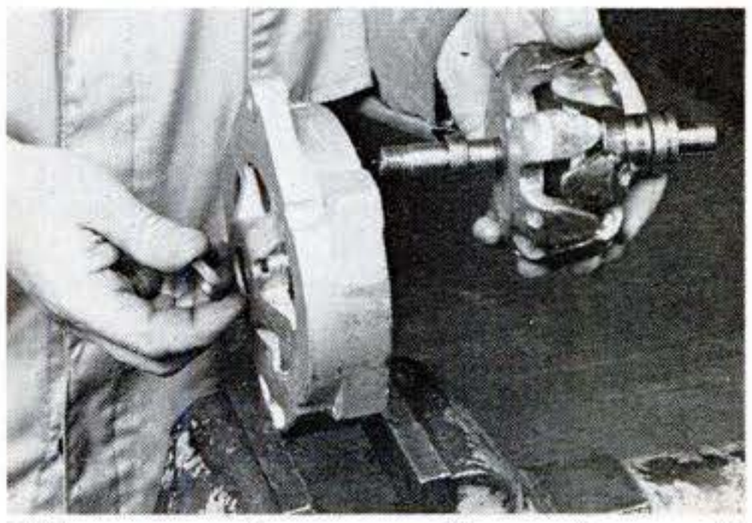
Separate the end frames. They may come apart easily, or you may have to pry them apart with a screwdriver, as shown here. Take care not to drop either half.



To remove the pulley—except on Chryslers—insert an Allen wrench of the correct size in the rotor shaft to hold it, and remove pulley nut with box-end wrench.



Spin the front pulley to check the bearing. If you feel any roughness, you must replace the bearing, because it is a permanently sealed ball bearing.



When removing rotor from drive end frame, note presence of any spacer washers. In this case there are two washers. Note that they are not the same width.

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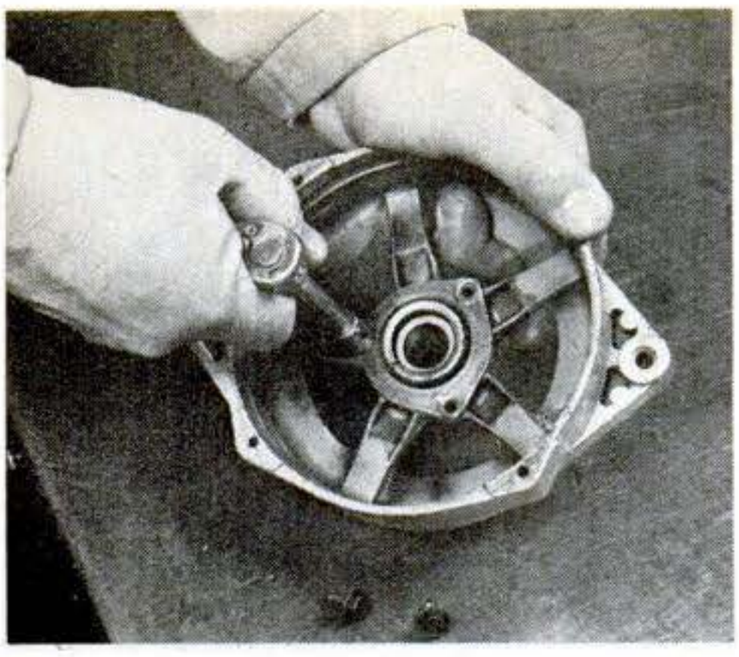
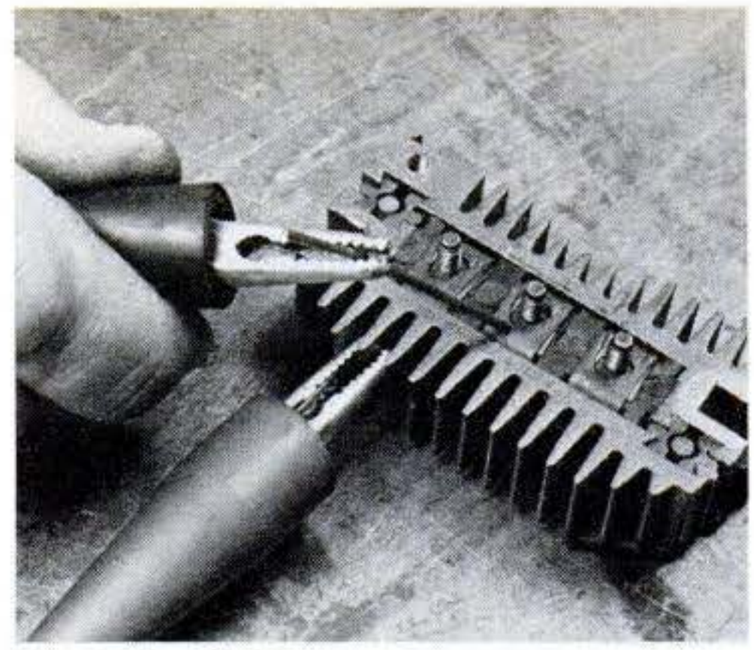
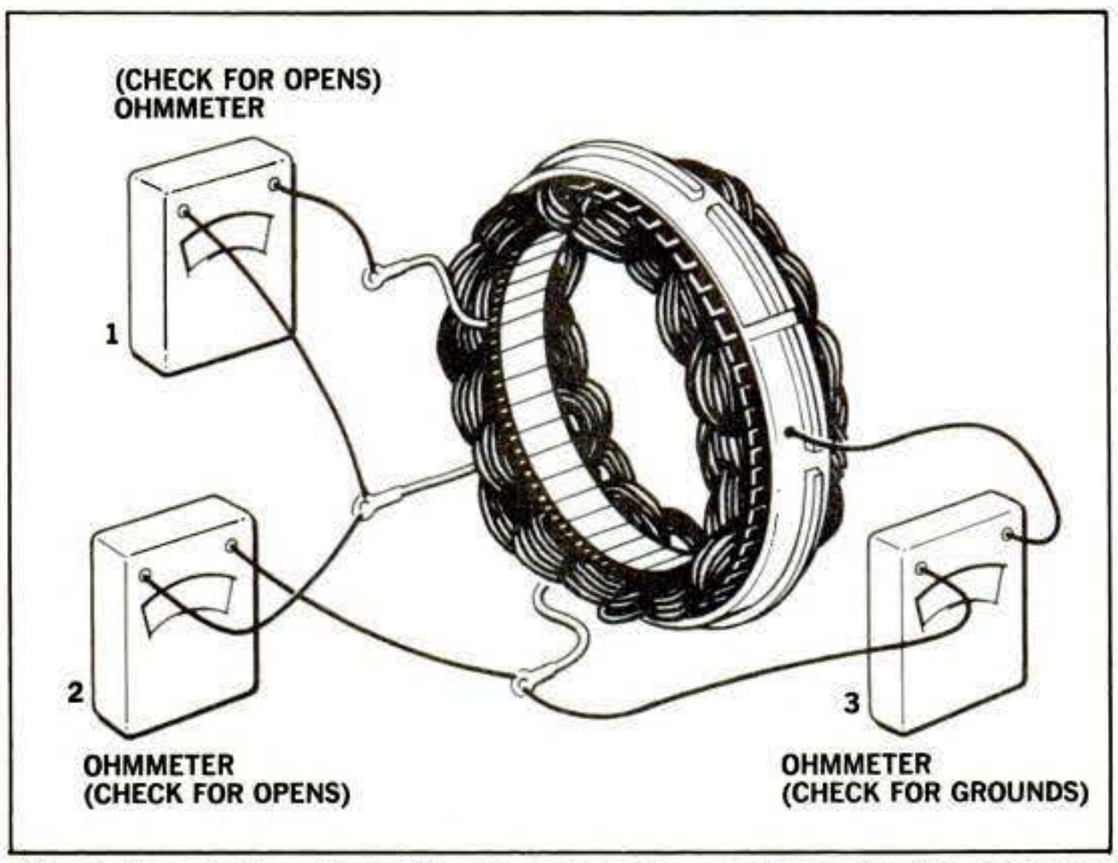


To remove the front bearing, remove the bolts that hold the bearing retainer to the end frame and lift the retainer away. The pressed-in bearing is now ready for removal. There are special tools available for removing and installing pressed-in bearings. But you don't need them if you follow the procedure at right.

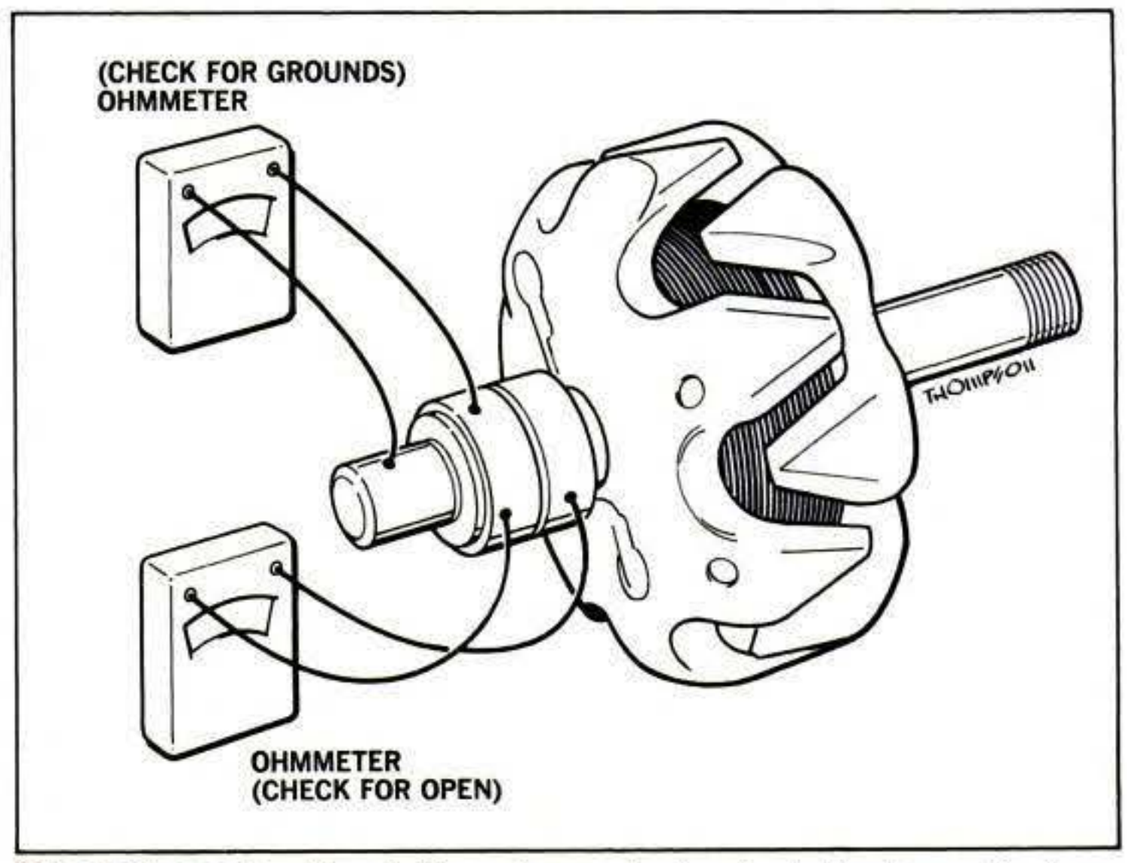
Use a socket that fits against the bearing's inside race to knock the bearing out with a plastic hammer or rubber mallet. To replace the front bearing, use a socket that fits against the bearing's outside race and tap the bearing in. After the bearing is in place, replace the bearing retainer and tighten the bearing-retainer bolts.



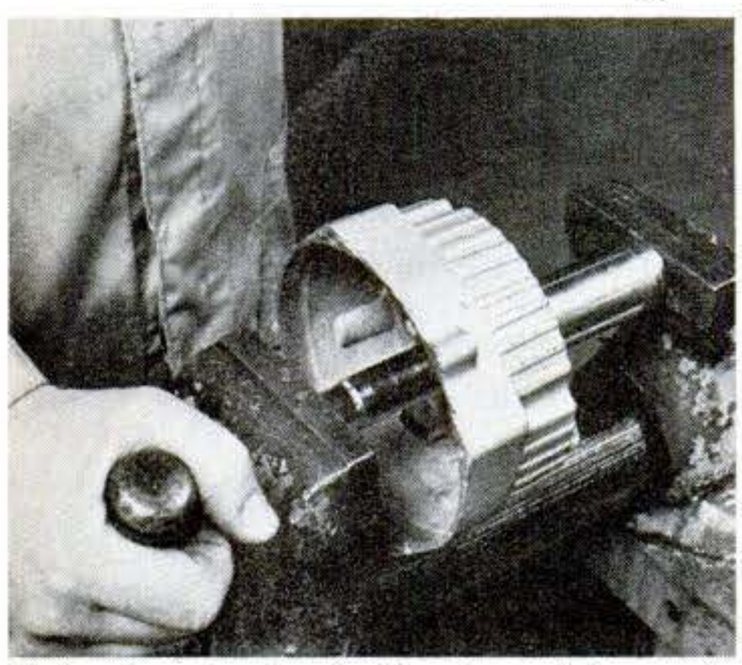
Check the diodes. Each should permit current flow in only one direction. Shop manual will give you instructions for checking. This is a GM rectifier bridge, which contains six diodes. An ohmmeter or a 12-volt test lamp can be used to check them. But do not use 110-volt test lamp. It will destroy the diodes.



Check the stator. Make the three hookups shown in the drawing. If you get high resistance when connections 1 or 2 are made, the stator windings are open. Replace the stator. You should get infinite resistance when hookup 3 is made. If the resistance is low, the stator is grounded and must be replaced. But if the stator is bad, it may be cheaper to buy a rebuilt alternator.

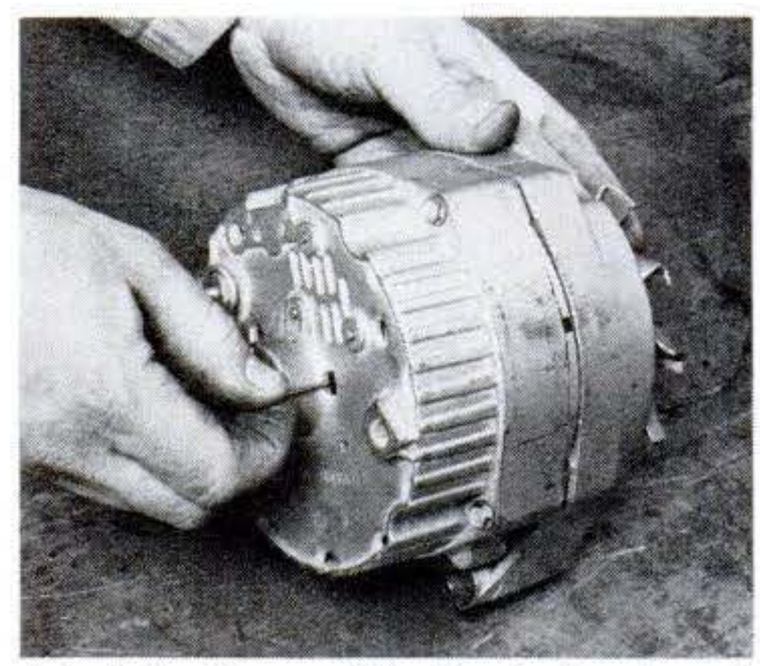


Check the rotor. Touch the ohmmeter leads to the two slip rings. You should get a low reading (see shop-manual specs). If the reading is not within the spec, replace the rotor. Touch one ohmmeter lead to a slip ring and the other to the shaft. Reading should be infinity. If it's not, winding is grounded and rotor must be replaced. Again, a rebuilt alternator may be cheaper.



If the bearing in the brush end frame is good, relube it with wheel-bearing grease. If the bearing rollers are galled, pitted, or corroded, replace the bearing. To remove it, place a socket (with an ID larger than the bearing OD) on the outside of the end frame. Place a small socket on the inside to fit against the bearing. Close the vise, and the bearing will move into the big socket. Press in the new bearing by reversing the removal procedure.

Brushes must be retracted during reassembly—except on Chrysler alternators. With Chryslers (as shown earlier), the brushes can be removed and replaced without disassembling the alternator. With other makes, however, a means is provided to keep the brushes retracted until the rotor is positioned in the brush end frame and the alternator is completely assembled. Push the brushes in and insert a thin piece of wire in the holes.



A hole is also provided in the brush end frame through which the wire can protrude as the rotor is slipped into place. Leave the wire protruding through the hole until the bolts that hold the two end frames together have been tightened. Then pull the wire out. This allows the brush springs to push the brushes against the rotor's slip rings. Don't forget to remove the wire. If you leave it in, the alternator won't produce any current.

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We left our hearts in San Francisco ...and a case of Canadian Club.

San Francisco! What better place to hide a case of golden Canadian Club than the city where millions came to seek gold in the Gold Rush of 1849?

So, we boarded a cable car on our way to hide a case of the world's finest-tasting whisky in America's most beautiful city. Do you know San Francisco well enough to find the C.C.?

A BART ride, a street with a past.

Start at BART's last city stop, and take a 30-cent ride. Change to another mode of transit, and ride until you can transfer again. Do so, and head for the farthest terminus, but debark at the first right-angle. Stroll a nearby street till it suggests a profession. Then head back toward your latter mode of transportation one block closer to your former. Where idlers gather, note who stays longest.

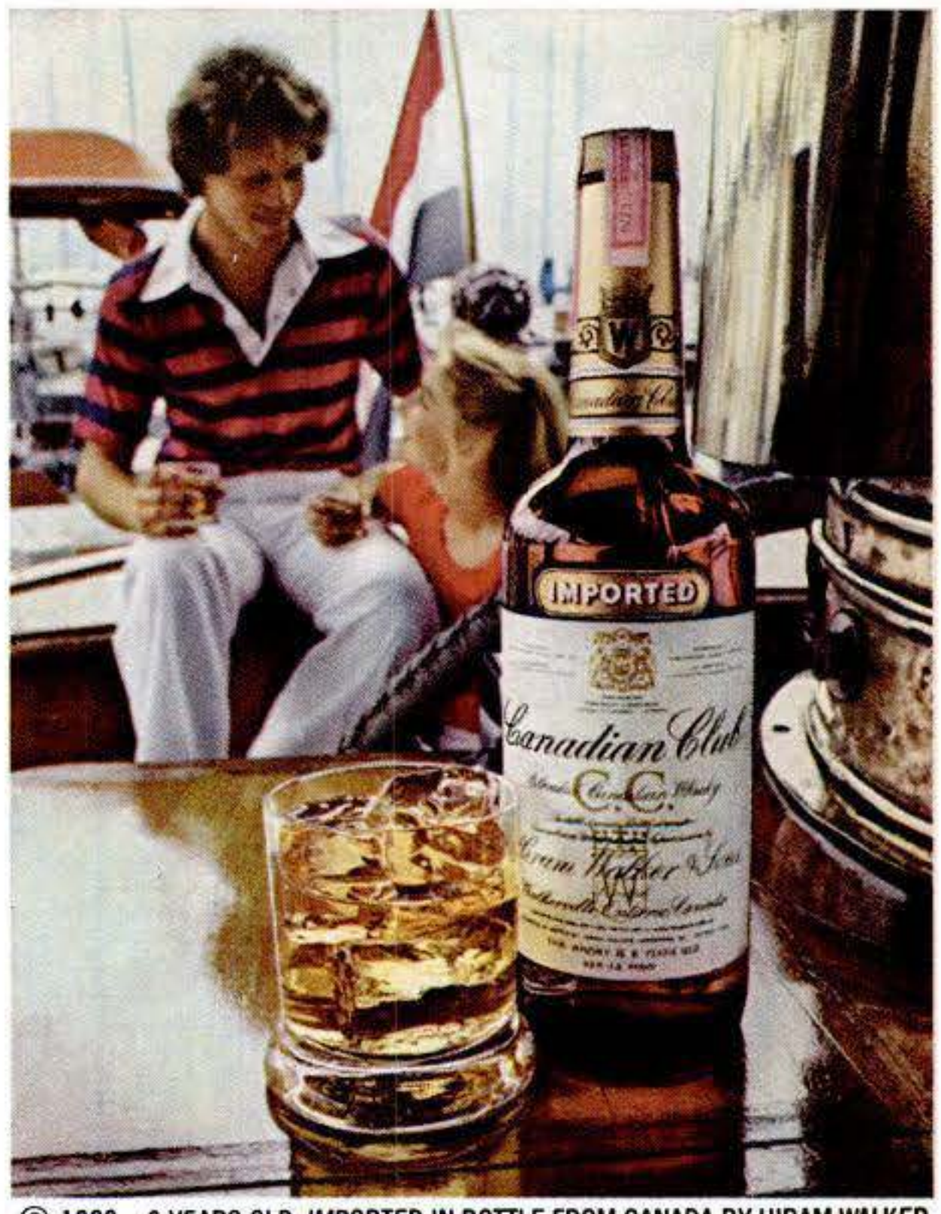
Find a way out of town but stay in.

Now head straight to some rails and follow them as far as necessary to meet a way named for an important Gold Rush figure. Let it lead you to a way out of the city, but don't leave. (If you've made it this far, don't think things are looking up.) Now return to the last route you were directed to. Somewhere along it we hid our Canadian Club. Things you've seen should tell you where.

Tell the boss, "C.C., please."

When you reach it, tell the man in charge "C.C., please." You'll receive a case of Canadian Club, the world's finest-tasting whisky.

As you'll discover, C.C. is smoother and lighter than other whiskies. So try it on the rocks or in a sour or Manhattan. Millions know that Canadian Club is worth searching for. And 2,600 San Francisco Bay Area bars and restaurants know it's worth serving. So enjoy yourself. Say "C.C., please."



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Canadian Club

"The Best In The House"®

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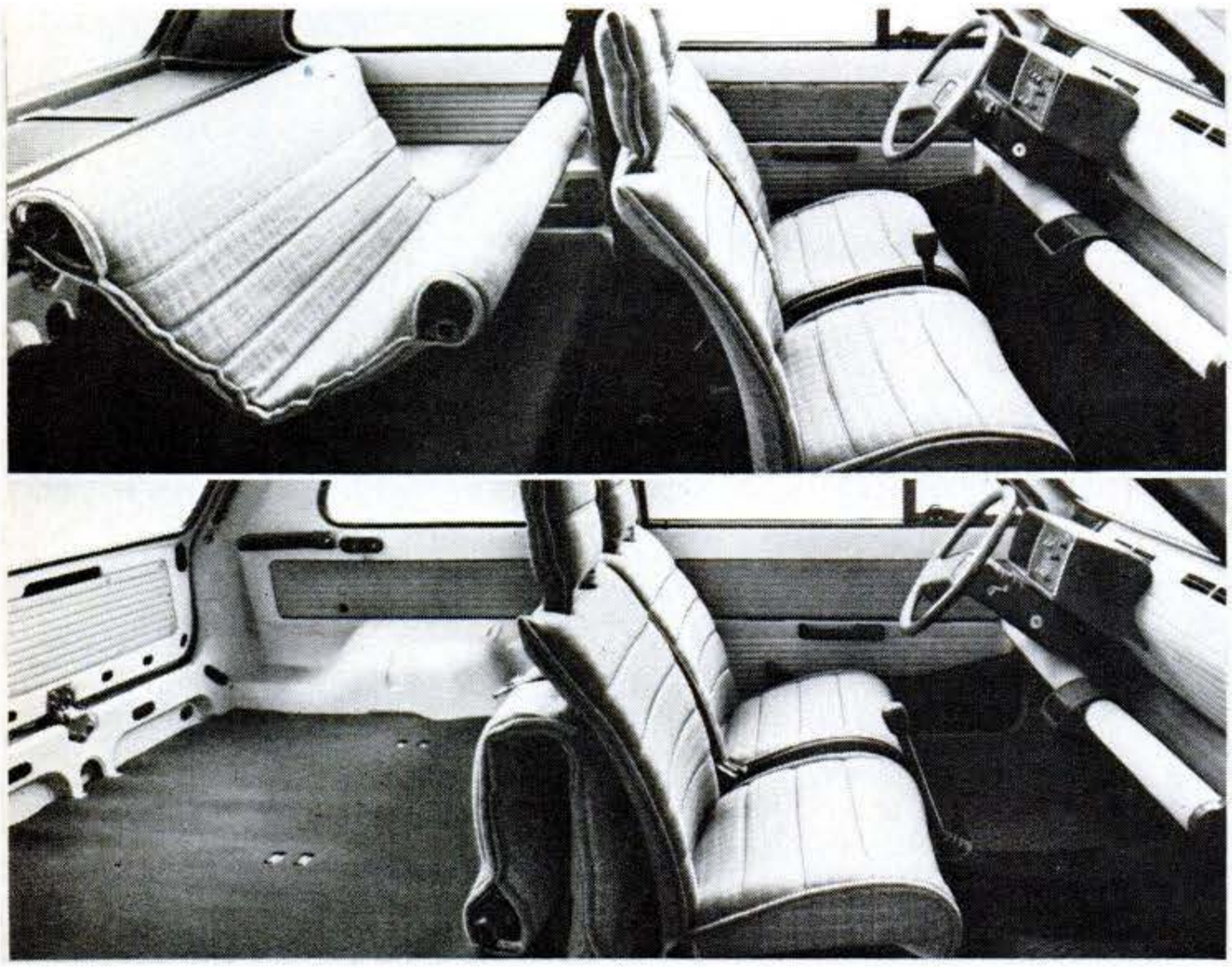
6-position seats

adjust for sitting, sleeping, or schlepping

Quick-change seat pads switch positions to give the interior setup you want

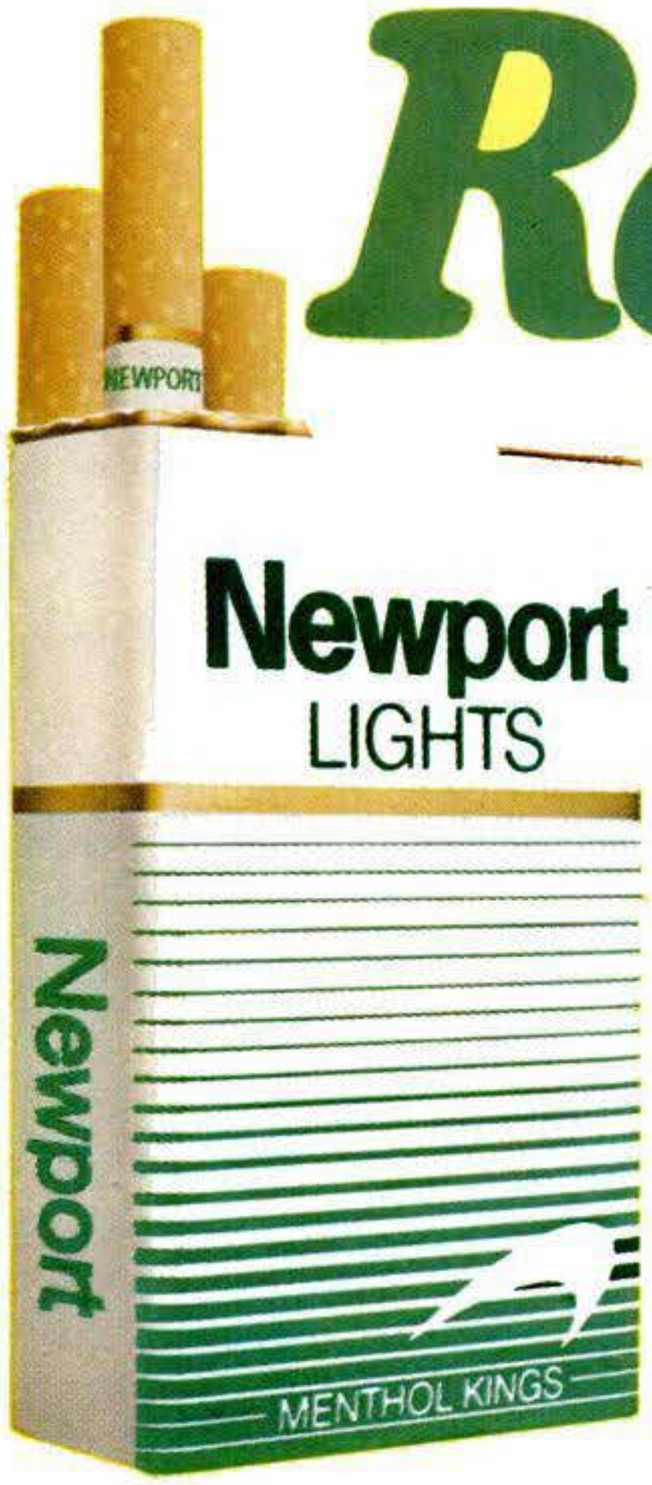
By DAVID SCOTT



Whether you want to nap, move a bulky chair, or just sit, you can do it in Fiat's new subcompact Panda. Its versatile seats can be shifted into at least six different positions, according to passenger, luggage, and snoozing requirements. That gives the tiny Panda exceptional cargo-carrying capabilities—or even the ability to become a mobile bedroom.

What makes it all possible are seats that can be moved into various modes at will. The rear seat is a thin, resilient pad, slung between two telescoping poles. When the poles rest in two side sockets, the seat is in a comfortable upright position. Plug the poles into sockets closer to the front, and the seat folds up to stretch cargo volume to 32 cubic feet. Different arrangements allow the seat to hang like a

Flexible-pad design gives Panda seats their versatility. Pads hang between two poles to make a comfortable hammock, or can be removed at will. Passenger seat, driver seat, and dash console all come out for more space or easy cleaning.



Revive your taste!

Newport Lights

© Lorillard, U.S.A., 1980

10 mg. "tar", 0.8 mg. nicotine av. per cigarette, FTC Report January 1980.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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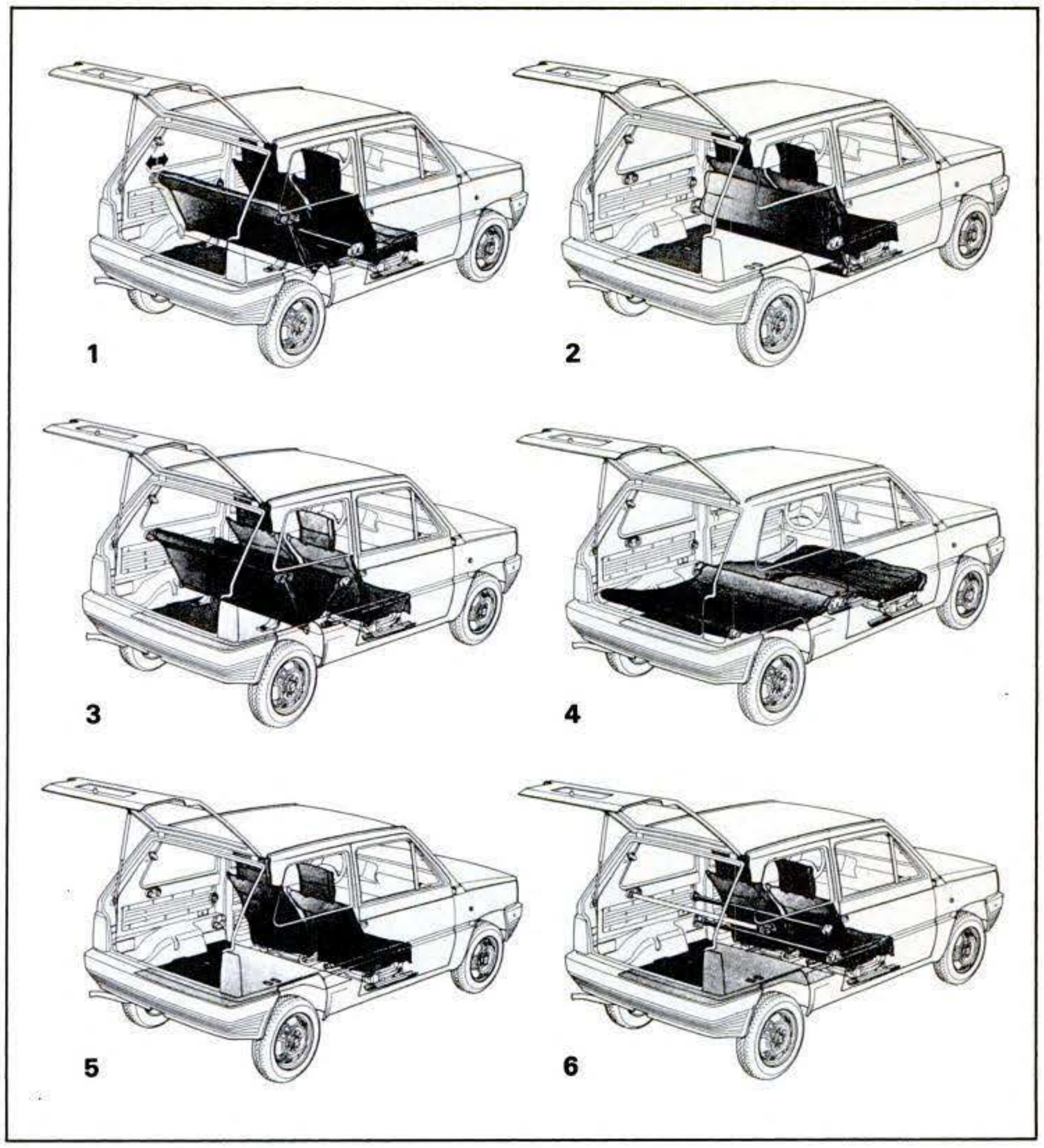
child's hammock, stretch out flat with the reclining front seats to make a double bed, or be removed entirely for 38 cubic feet of cargo space. Carrying fragile objects? You can adjust the poles so the seats cushion the objects you're carrying.

That's not all. The front seats come out, too, to provide extra room. And the dash console can be removed for easy cleaning.

The Panda's body is covered by a shock-absorbent plastic coating to reduce damage in case of impact. Neat, boxed-off contours help reduce damage done to other vehicles on impact, too. "If you're going to be hit by a car, this is a good one to be hit by," says Bill Baker, a Fiat spokesman.

In addition, the Panda is very fuel-efficient—48 mpg at a steady 56 mph, according to Fiat, with normal usage averaging around 40 mpg. A transverse-mounted 45-hp engine drives the front wheels of the car.

The 11-foot hatchback is "cheap to make, cheap to run," says Fiat. The Panda is being produced in Italy and Spain; it won't be sold here. PS



Panda's rear seat can sit upright (1), fold forward for more cargo space (2), hang like a hammock (3), or lie flat with front seat to make a double bed (4). You can remove it entirely (5), or fit poles over fragile loads for protection (6).

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DEFENSIVE LINES.

AC Air and Oil Filters. When you're talking about filters, the name of the game is defense. AC Oil Filters help trap damaging particles and clean your oil. AC Oil Filters also help provide many thousands of miles of engine protection. Air filters are part of the defense story, too. AC Air Filters are designed to include an oil-wetted paper element to promote dirt-holding capacity and to help remove dirt that can cause engine wear. AC Filters are recommended replacements for General Motors cars and light trucks and are available for most other American-built vehicles. So keep your guard up. Wherever you go for parts or service, ask for reliable AC Filters for your car's protection.
AC-Delco Division of General Motors Corporation.

THANKS, AC.

AC GM Delco

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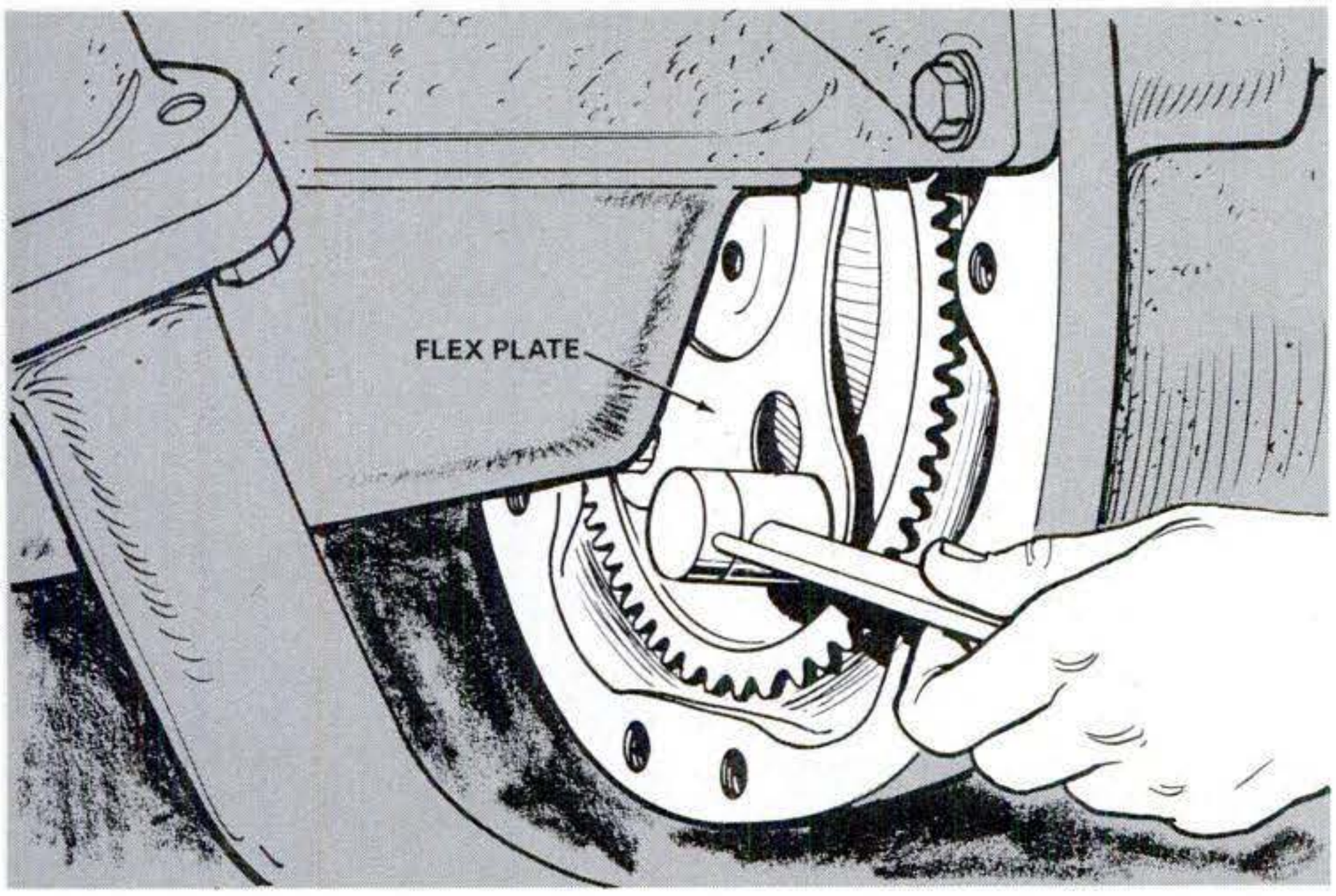
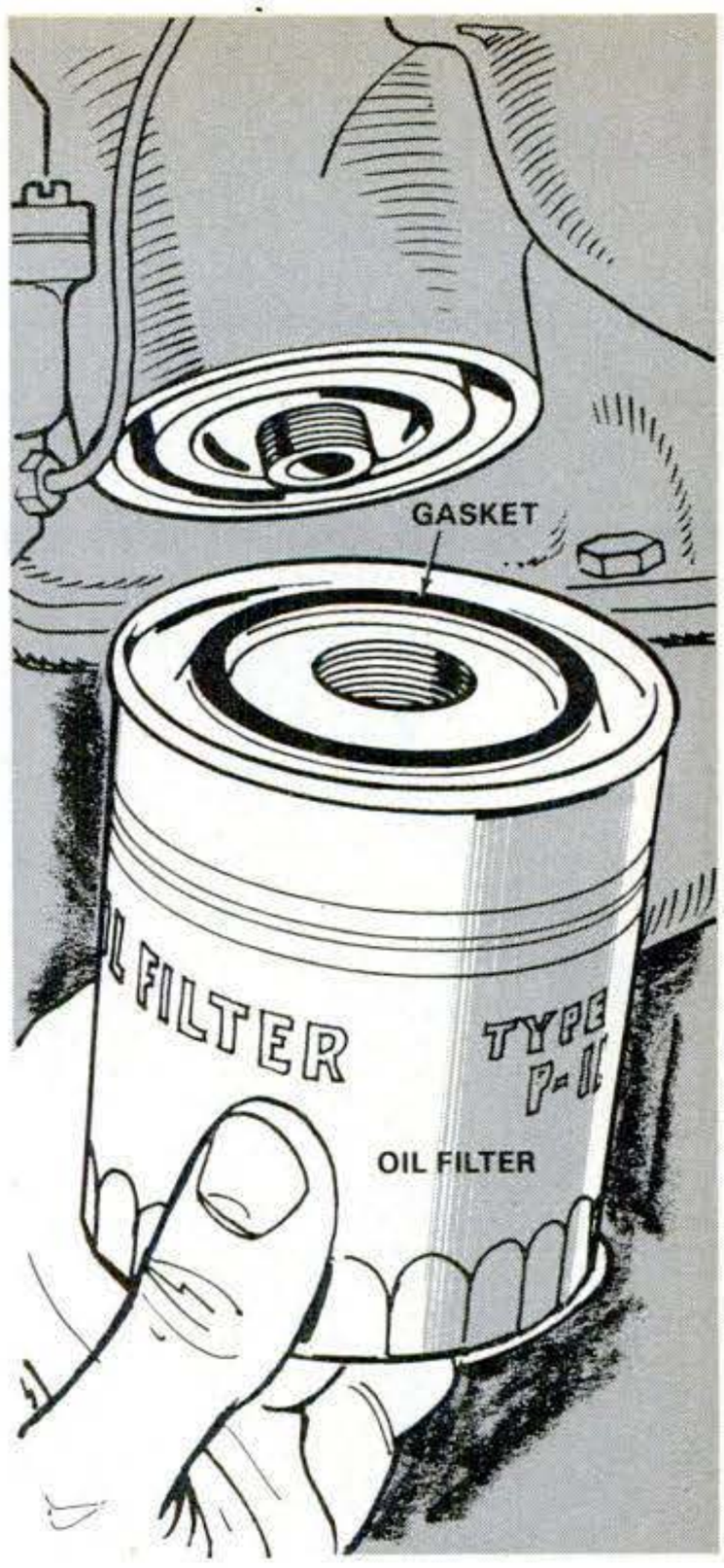
TAKING CARE OF YOUR CAR

By RAY HILL

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



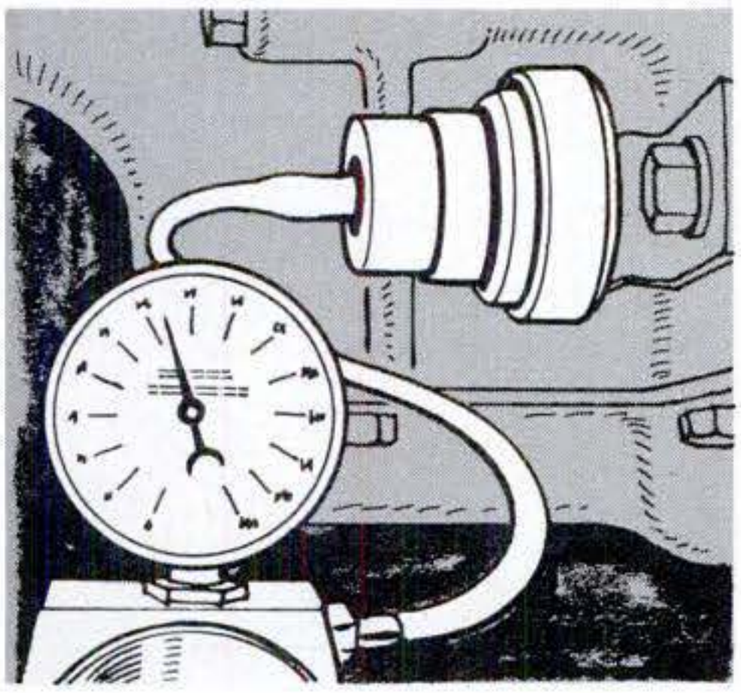


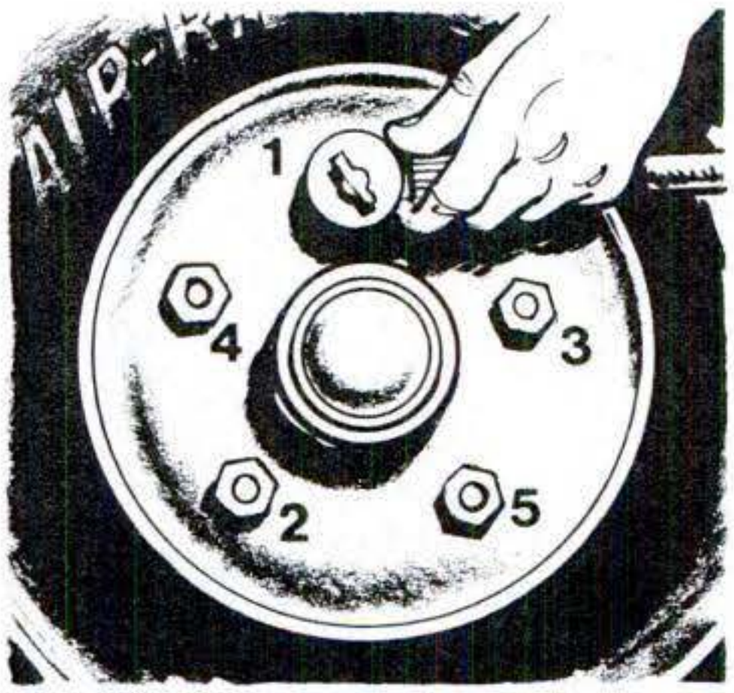
Is that engine noise a bad main bearing? It may not be

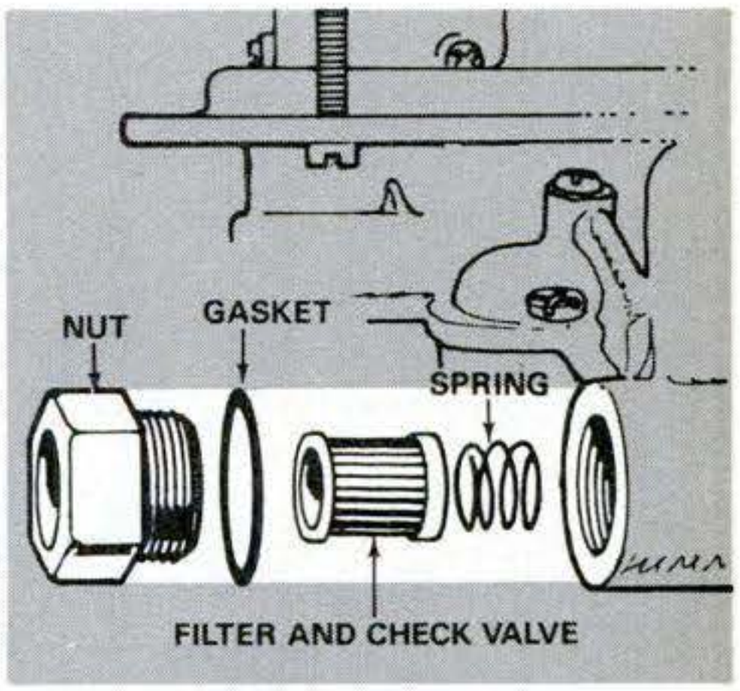
A noise coming from the engine that sounds like a bearing noise may be caused by a loose torque converter. To check, remove the inspection cover and check the bolts or nuts that hold the torque converter to the flex plate. If they have loosened, this allows the torque converter to move, resulting in a clunking sound. If they are loose, use a torque wrench to tighten them to shop-manual specs. Also inspect the flex plate for cracks, which may have resulted from the torque converter flopping around. If any cracks are present, replace the plate.

Don't use grease

For some gaskets, a thin film of grease on either side works fine. Not on an oil-filter gasket, though; putting grease on it can make the gasket extra slippery, and when you tighten the oil filter you can push the gasket out, resulting in an oil leak. Coat this gasket with oil.







Late-shifting transmission

If your automatic transmission is slow to upshift and it has a vacuum modulator (GM and Ford cars do), remove the vacuum line to the modulator and check for fluid leakage. If fluid is visible, replace the modulator. If you don't see any fluid, check the modulator with a vacuum pump. It should hold 15 inches without leaking down. If it doesn't, replace the modulator. Some Ford modulators have two vacuum taps; one is for the EGR valve. You must plug the EGR tap before applying vacuum to the other tap.

Tightening lug nuts

Any lug nuts should be tightened in a star pattern. With disc brakes it's especially important. Failure to do it can cause a warped rotor. The best way is with a torque wrench in three increments. On the first pass tighten each nut to one-third of the final shop-manual torque figure. On the second pass, tighten to two-thirds of that figure. And on the third go-round, tighten to spec. If you can't use a torque wrench, tighten the lug nuts in a star pattern in three increments—snug, half-tight, and full-tight.

Replacing a gas filter

If your gas filter is at the carb inlet, and it's one of those with a spring behind it, be careful when screwing the large nut into the carb inlet. Because the spring is pushing out against the filter, it may cause you to cross-thread the nut. To prevent this, start the nut by hand, and screw it in several turns by hand. If you encounter any resistance during initial threading, remove the nut and try again. If, despite your best efforts, you ruin the threads, a repair kit is available. You can buy it at some local auto-parts stores.

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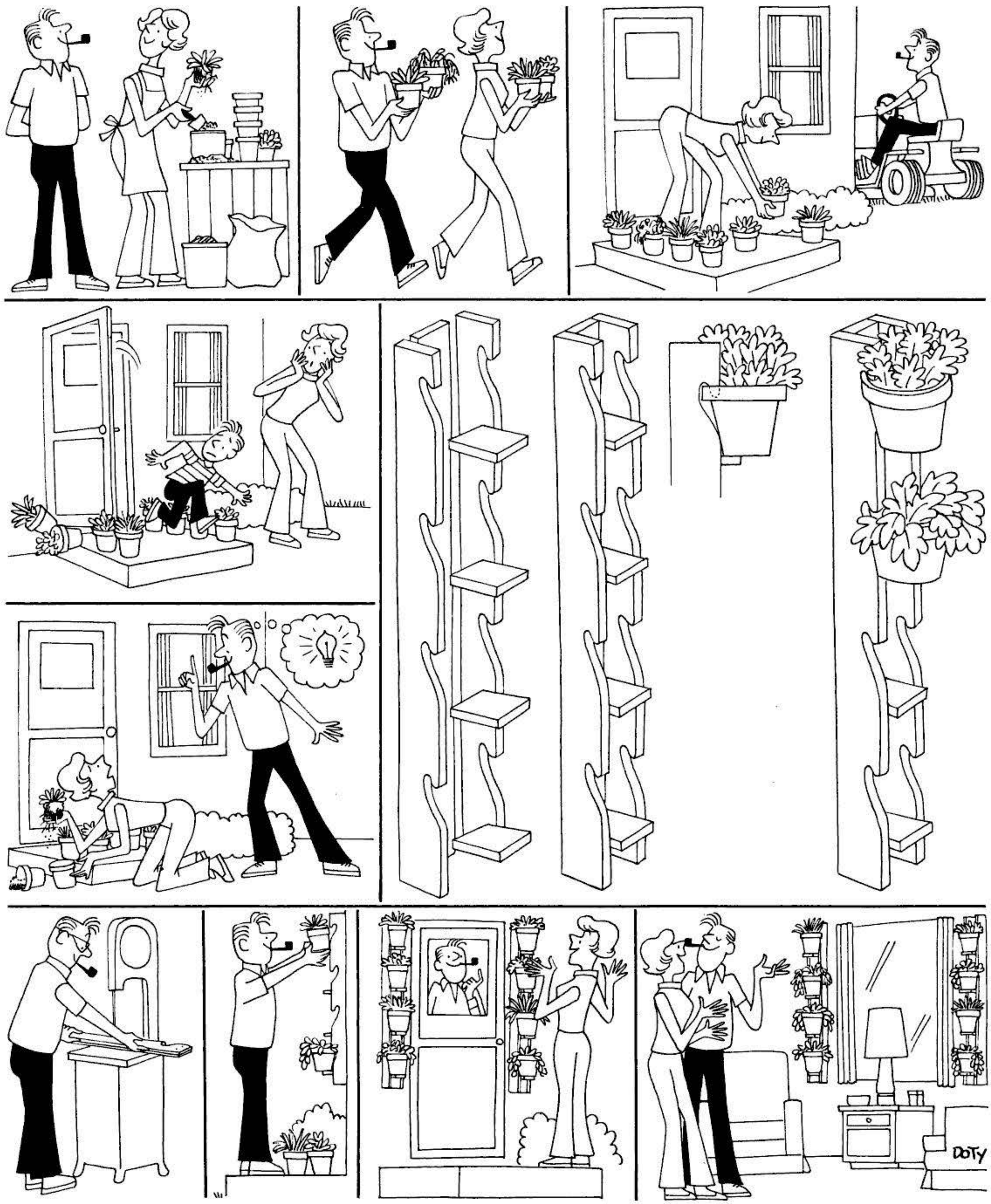
WORDLESS WORKSHOP

By ROY DOTY

$50 to David Dowless of Geneva, Ill., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas are acknowledged.



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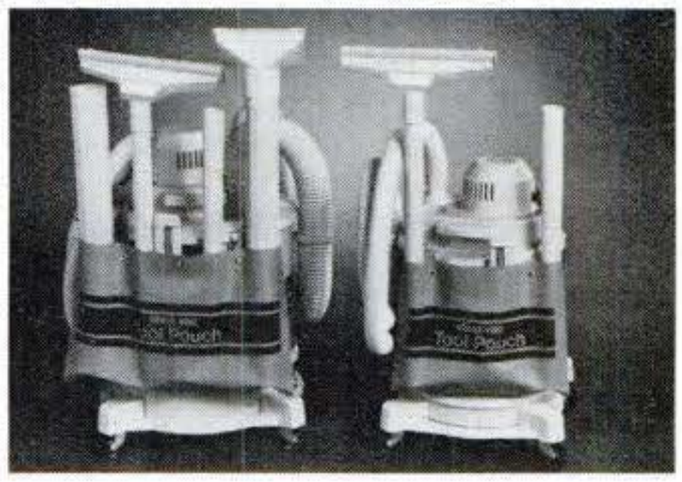
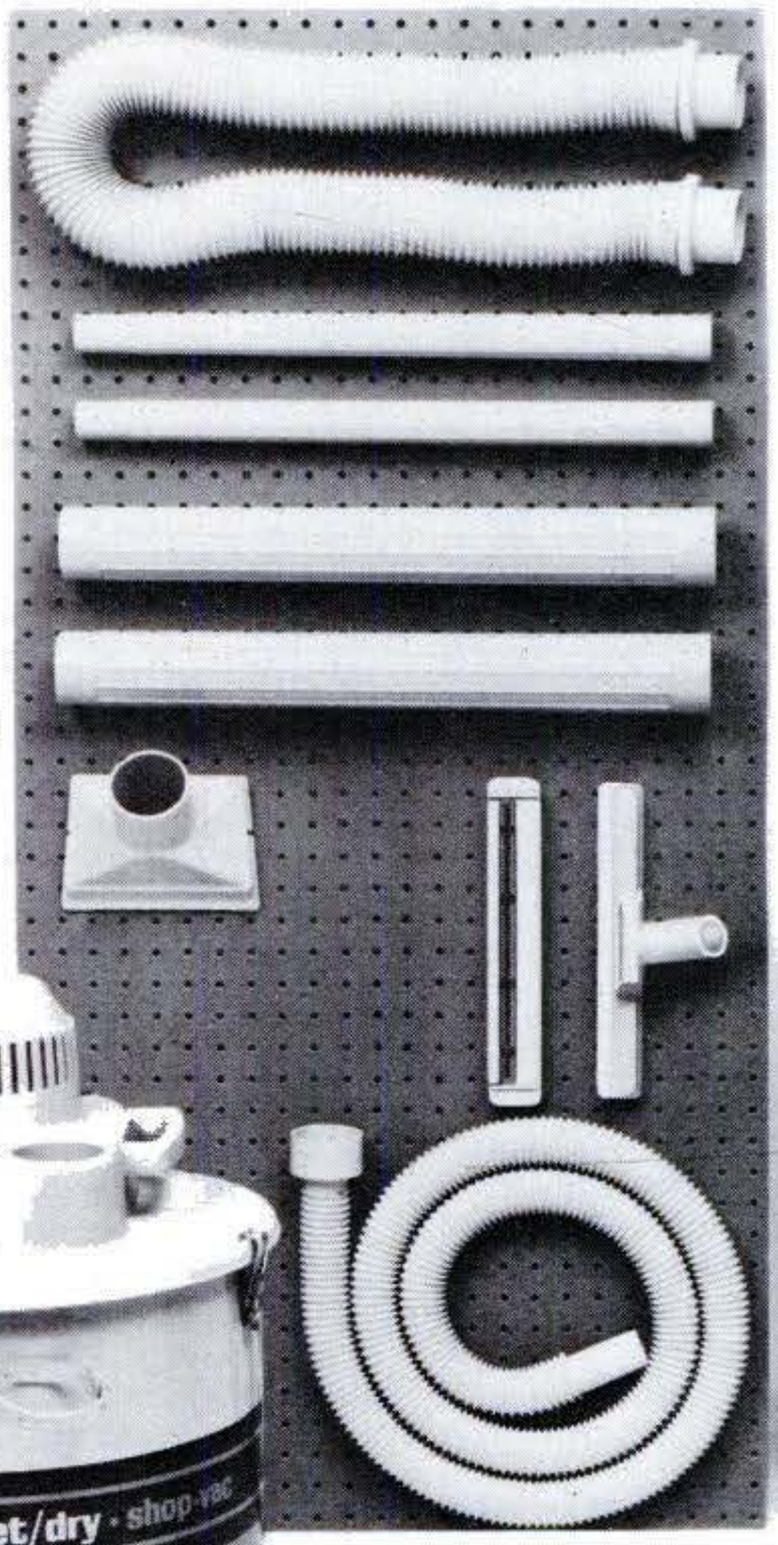
MAKE A CLEAN SWEEP OF SHOP-VAC® SAVINGS... AT K MART.

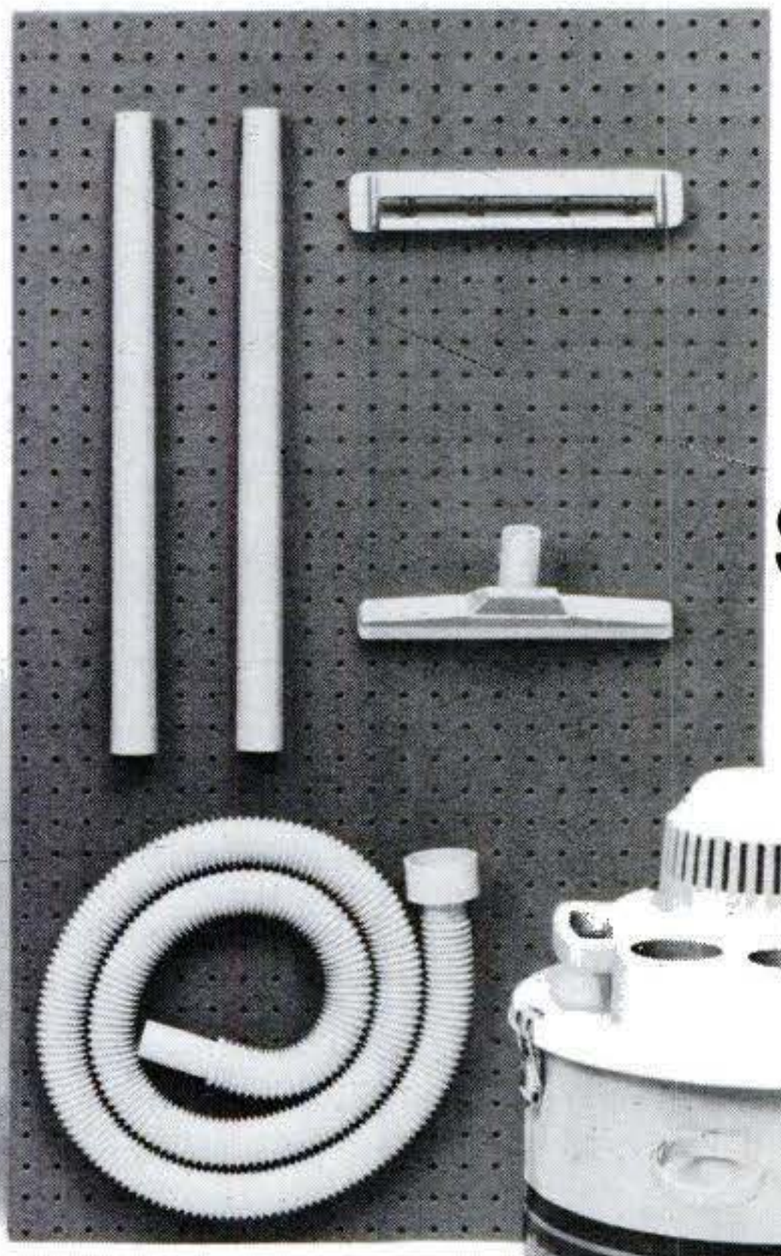
The Vacs that revolutionized heavy-duty cleaning are sale-priced now at K mart. With features like: • Double filtration system to pick up *wet and dry* material • Automatic shutoff to prevent overflow • Built-in drain • Powerful, heavy-duty .94-hp, 6-amp motor to power-clean workshop, basement, garage, car, patio or home • Handy tool pouch to keep accessories with the vacuum cleaner • UL listed.

The Wet/Dry Shop Vac is available in two models: an eight-gallon dual deluxe with nine standard attachments (Model 600-14); and a five-gallon deluxe with five standard attachments (Model 600-07).

Both models include a four-wheel dolly with swivel casters for ease of maneuvering. On sale through June 28 at over 1,600 K mart stores across the U.S.A.

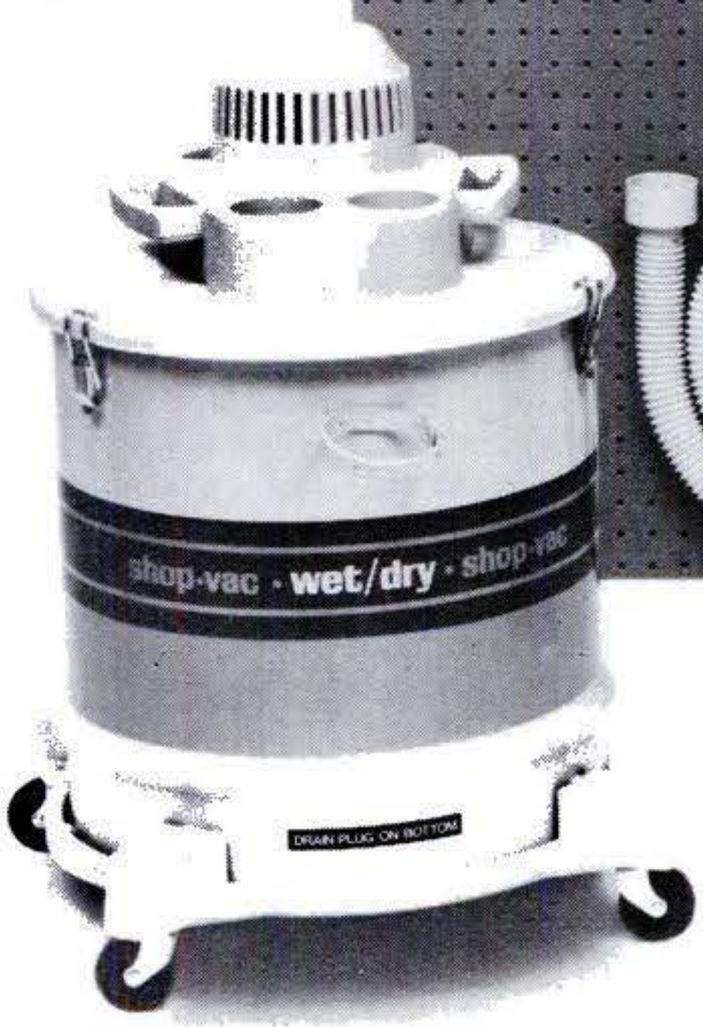






$39.97
(Model 600-14)

$32.97
(Model 600-07)



Kmart®

The Saving Place

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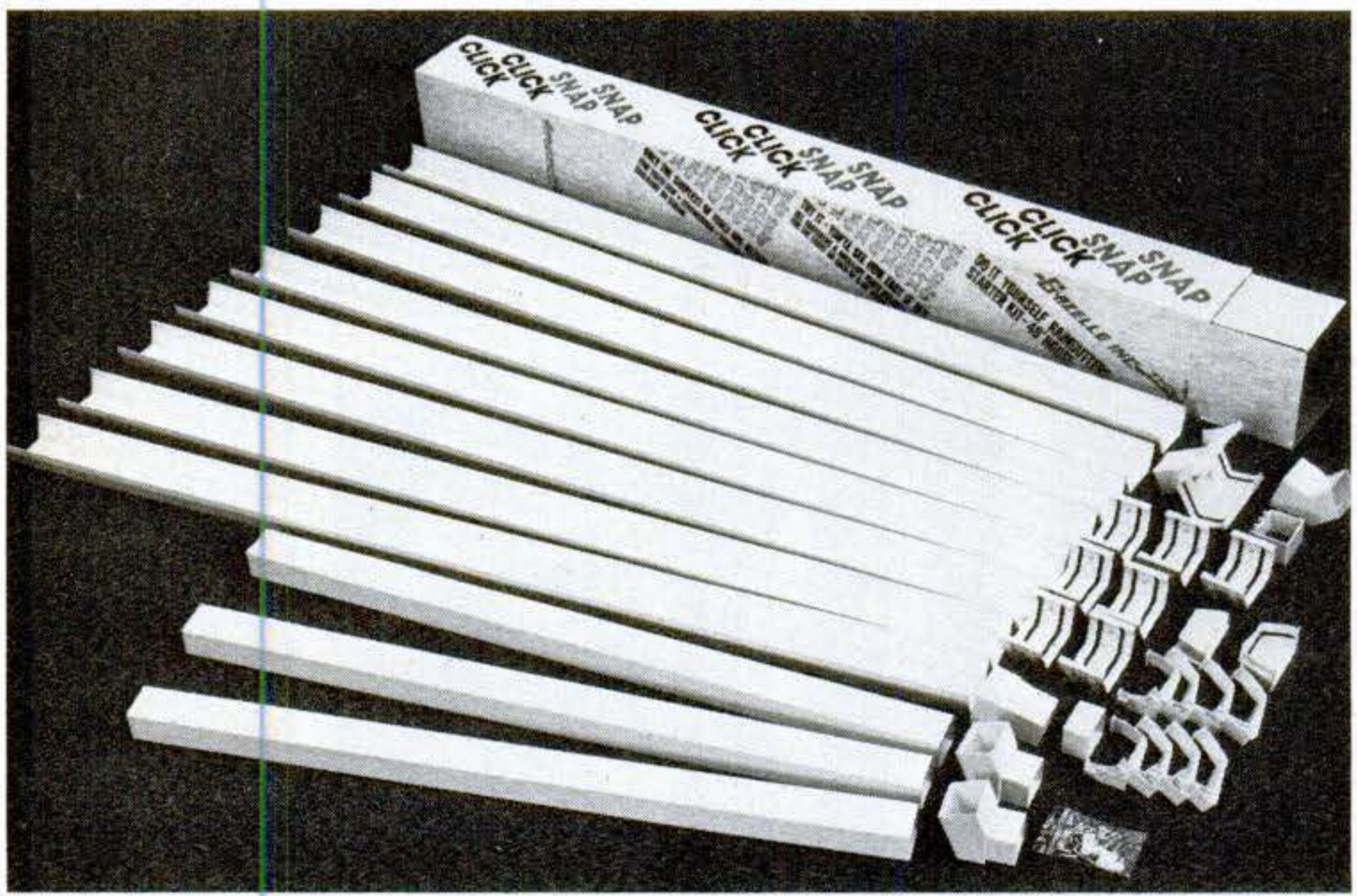
SHOP TALK

By AL LEES

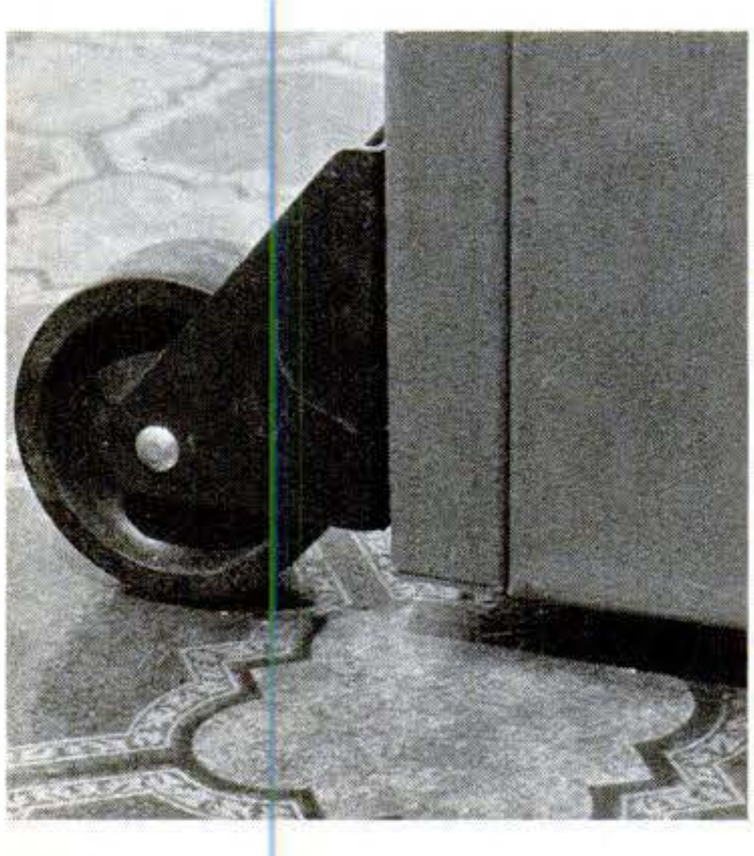
Vinyl to get you started

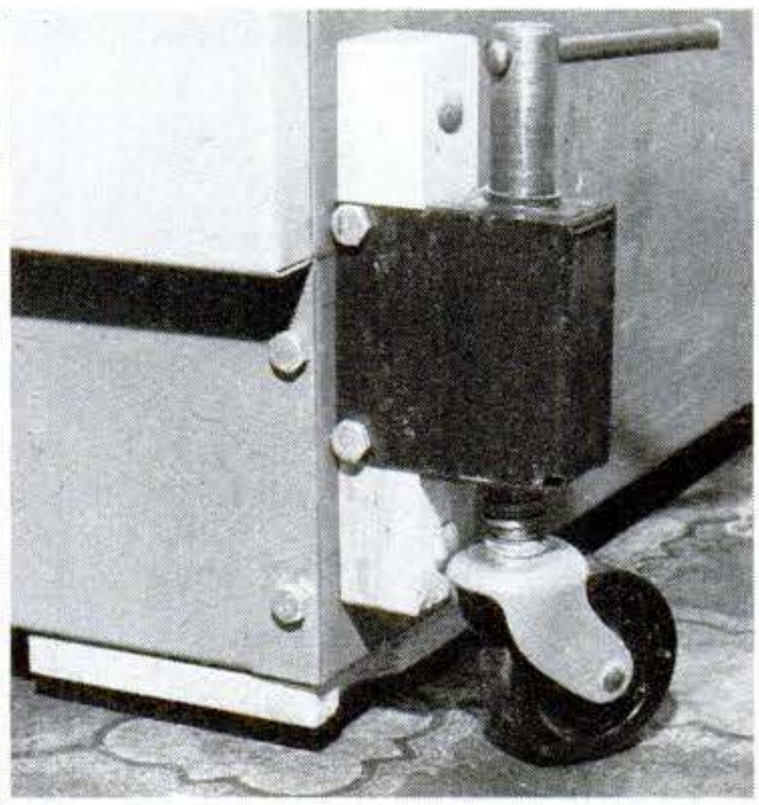
Our review of new vinyl guttering systems in May's Home Improvement issue mentioned (but did not show) a system just introduced by Gazelle, Inc., Box 701, Tomah, Wis. 54660. The photo below displays its starter kit for the front or rear of a 48-ft. house. You can carry a package out of the store (suggested retail: $135) that contains all gutter, downspout, and fittings needed to complete the installation. If you can't find the package locally, write to the company.



Put your tools on wheels

A couple more photos that got squeezed out of May's Home Improvement section—this time from Tom Jones' roundup of casters, glides and wheels: For occasional moving of a stationary power tool (such as the radial-arm-saw cabinet seen here), mount a pair of retractable casters at the front of the cabinet as shown at right—on blocks bolted through the face. When the saw is in use, the cabinet rests on the plywood pad that's fastened under the base. At the rear of the same cabinet, mount a second pair of the type of caster shown in the left photo. Slip a plywood pad (not shown) under the base before you retract the front casters. Your tool is then firmly rooted for use, won't dig into a finished floor, yet can be repositioned whenever necessary for special projects or workshop cleanup.





Sorry, you can't get Clobber'd

We never said it in this magazine, but one of the Popular Science Skill Books *(Home Guide to Plumbing, Heating, Air Conditioning)* implies that a sulfuric-acid-type drain cleaner, Hercules Clobber, can be used by homeowners if proper precautions are followed.

Not so, says Hercules; sale is restricted to professionals. Hercules believes that *any* acid drain opener is hazardous in inexperienced hands, so has never advertised Clobber to the consumer. In fact, the company went so far as to petition the Consumer Products Safety Commission to ban all acid drain products from retail sale. For safety's sake, don't use any acid drain cleaner—and don't try to buy Clobber unless you're a pro.

Welcome indoors, Ortho

Several years back, the world's largest company specializing in plant-protection products decided to branch out into publishing. Ortho—a division of Chevron Chemical—began, logically enough, with books on gardening and house plants. But with six new titles for 1980, their total is up to 28 volumes, so they've not only expanded into building projects (such as decks)—they've ventured *inside* for the first time with *Basic Home Repairs.* It's a fine manual for new homeowners or apartment dwellers, and like all other Ortho books, it's a $4.95 paperback with lavish color illustrations. At home centers.

Wood burners, unite!

An interesting letter from Illinois:

"We are a not-for-profit cooperative of wood burners and suppliers. With the increase in the use of wood as a heating fuel, we've experienced price increases in firewood that make it as expensive a fuel as oil, natural gas, or coal.

"We have chosen energy self-sufficiency for ourselves, and see it as an urgent goal for our nation. Wood heat is an essential element of energy independence in the U.S.—but irregular and outrageous prices, inconsistent with supply, make self-sufficiency difficult to maintain.

"Our goals are: stabilization of the cost of wood fuel on a local level, and lobbying for legislation that would treat wood as a valuable natural resource on a national level. For further information, contact Buck Rogers at (815) 962–5050. Or write Woodburners Cooperatives, Box 137, Rt. 1, Durand, Ill. 61024."

Commendable intent. I have two questions (both frivolous): Buck Rogers as a *wood* burner? Is Durand to become New Chicago?

And now there are three

Olympic Stain has introduced a clear, penetrating, water-repellent wood preservative—just in time for early summer spruce-up. The product will compete mainly with Woodlife and Cuprinol. Olympic also offers a water-repellent, preservative *stain,* in 10 semitransparent colors. It's called Weather Screen and is for siding, fences, and decks. PS

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Litton's New Pocket Socket.™

THE RATCHET WITH THE SOCKETS IN THE HANDLE.™

MADE IN U.S.A.

Practical.
Heat-treated, 45-tooth thumbwheel ratchet snaps out for tightest spots.

Super tough.
Unitized, alloy-steel reinforced handle for high torque.

Pocket-size, convenient.
Pull-out, spill-proof socket tray.

Available wherever fine tools are sold.

Made in America. Guaranteed forever.

For home, car, bike.
5 heat-treated ¼" drive sockets for most popular fasteners.

PATENT PENDING

Litton
Changing the way America works.

FREE ELECTRICITY

START GENERATING YOUR OWN POWER
FROM RENEWABLE ENERGY SOURCES
BUY THIS GENERATOR—GET FREE PLANS

THE AMAZING TC25G PERMANENT MAGNET LOW-RPM DC GENERATOR

SO SENSITIVE that it acts like a selsyn when connected to a small dc motor! Turn the TC25G generator shaft with your fingers and the motor rotates by the same amount - in either direction!

SO EFFICIENT that it can produce 12 volts at only 475 rpm!

SO POWERFUL that it can deliver over 6 amperes into a short circuit!

How did such an unusual generator get built? Here is the story:

The TC25G began as one of many components, in a unique low-cost wind generator - the Helius Rotor kit. It was during the development of this rotor that our engineers discovered there was no inexpensive, low rpm generator to be found anywhere, that was suitable for small windpower converters - or, for that matter, for water wheels, pedal power, solar engines, fuel-powered generators, or any other small energy needs.

It was tempting at the time to turn to "small" automotive alternators - which need several thousand rpm to generate the kind of voltage we wanted. They are large, heavy and also require an efficiency-killing step-up pulley, to achieve the necessary rpm to generate power from a small water wheel or windmill. Meanwhile, the price of oil and other fuels was beginning to skyrocket and many people were clearly not going to take these price hikes lying down: more and more people were turning to *free* renewable energy sources - solar, wind, water - not because they *had* to, at that time, but simply because it made good economic sense. Needing to produce exactly the right product for the growing boom in home-sized alternate energy products, Thermax engineers started from scratch to design the perfect small generator. It had to be inexpensive, light, and operate efficiently at low rpm (which no other small generator could do).

The result of this design program was the TC25G permanent-magnet dc generator - which may be exactly the generator you've been looking for, if you ever tried to build a small water wheel or windmill.

Later, at the Energy Lifestyle Show, visitors who tried our demonstration generator were so amazed by its sensitivity that some even looked underneath to see if there was a trick to it! Turned only by a finger, the TC25G would easily drive a small 12-volt motor.

Many energy buffs bought generators on the spot.

At first the Thermax sales personnel were surprised that so many customers were attracted by the generator itself, and didn't want to buy the whole windmill kit. Even without advertising, inquiries kept coming from do-it-yourself energy enthusiasts who really wanted to build their *own* power systems, not Thermax's or anyone else's.

So here you are - the ideal small dc generator, with plans (if you need them) to build several different renewable energy converters. Now you can start generating your own free, natural energy!

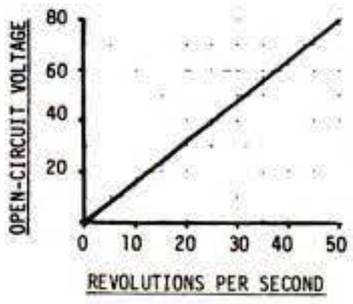
SPECIFICATIONS: TC25G GENERATOR

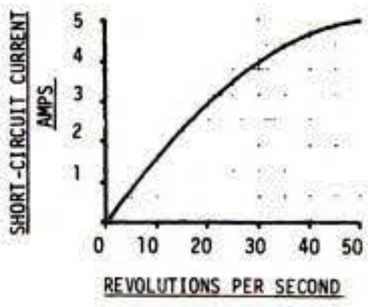
Two-pole permanent magnet dc generator.
Ten-slot armature wound with 0.4 mm (26 AWG) wire.
Internal resistance 4 ohms; heavy-duty long-life brushes.
Mounts by two 10-32 studs at shaft end of case.

Dimensions:	Case length 4⅞ inch	(124 mm)
	Case diameter 3¼ inch	(82 mm)
	Shaft diameter 5/16 inch	(7.94 mm)
	Weight 3.5 lb.	(16 kg)

Electrical Performance

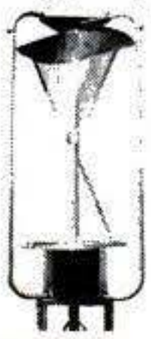
Rated for 12 volts dc, will generate 6, 12, 24 or 32 volts with appropriate voltage regulator.





FREE PLANS AND USER'S GUIDE

Order your TC25G now and receive, free with your generator, a complete applications guide: all you need to know about wiring, voltage regulators, batteries, inverters to step up to 110 volts ac, as well as plans for building the following energy producers:



HELIUS TC25K WINDPOWER CONVERTER

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A clinic on cars by Smokey Yunick, America's most famous mechanic

Wants a turbocharger

I have a 1980 Chevy Citation with the V6 engine. I understand Buick is going to offer a turbo version of the V6. Is it possible for me to install a turbo on my V6? Are there any special problems I need to be aware of?

Jack Webb, Racine, Wis.

If you do it, get a kit from a guaranteed expert. It can be done, but it can be a can of worms. A turbo is very sensitive to fuel quality.

A car for a rebuilt engine

I am in the process of rebuilding a 351-C with a two-barrel automatic transmission from a 1970 Torino. I am converting the automatic transmission to a three-speed. I'm also putting in new rings, main bearings, connecting-rod bearings, cam bearings, new valve seals, and doing a complete valve job.

I want to put this package in a Mustang, preferably one made prior to 1970. My dad disagrees, saying it would involve changing the frame. I know that I will have to change the drive shaft, motor mounts, and possibly the shocks, and the rear end to a 2.78 or higher. If you think this would not be feasible, please give me suggestions.

Michael Kolcun, Endwell, N.Y.

It will go in a Mustang, but it's gonna be expensive. The engine is way too big, and mileage will not be very good. The only transmission change worth making is for overdrive. I agree with your gear selection. Even taller gears, like 2.20:1, would be better.

No rear brakes

In January 1979 I bought a new Chevy K-10 4×4 truck. I've been driving with unsafe brakes ever since.

Only the front brakes do anything. In wet or snowy weather I put my life on the line every time I drive. When it's slippery, I can't even slow the truck down without the front wheels locking up, and if you really stand on the pedal, the rear wheels still do nothing. Whether the truck is empty or loaded, I don't notice any difference.

I've had it to the dealer several times and the factory rep *looked* at it once. The dealer says it's fine, just drive slower. The factory rep refused to do anything at all, says his company car does it, too. The dealer put it on the grease rack, and one mechanic put it in gear and held the brakes while helpers held the wheels by hand. They said there was "real fine" braking on rear wheels. They removed all the wheels and blew out the dirt.

I pulled the rear wheels and tightened the adjusters till I could barely get the hubs back on. Then I tried to tighten them more by backing and braking. No difference.

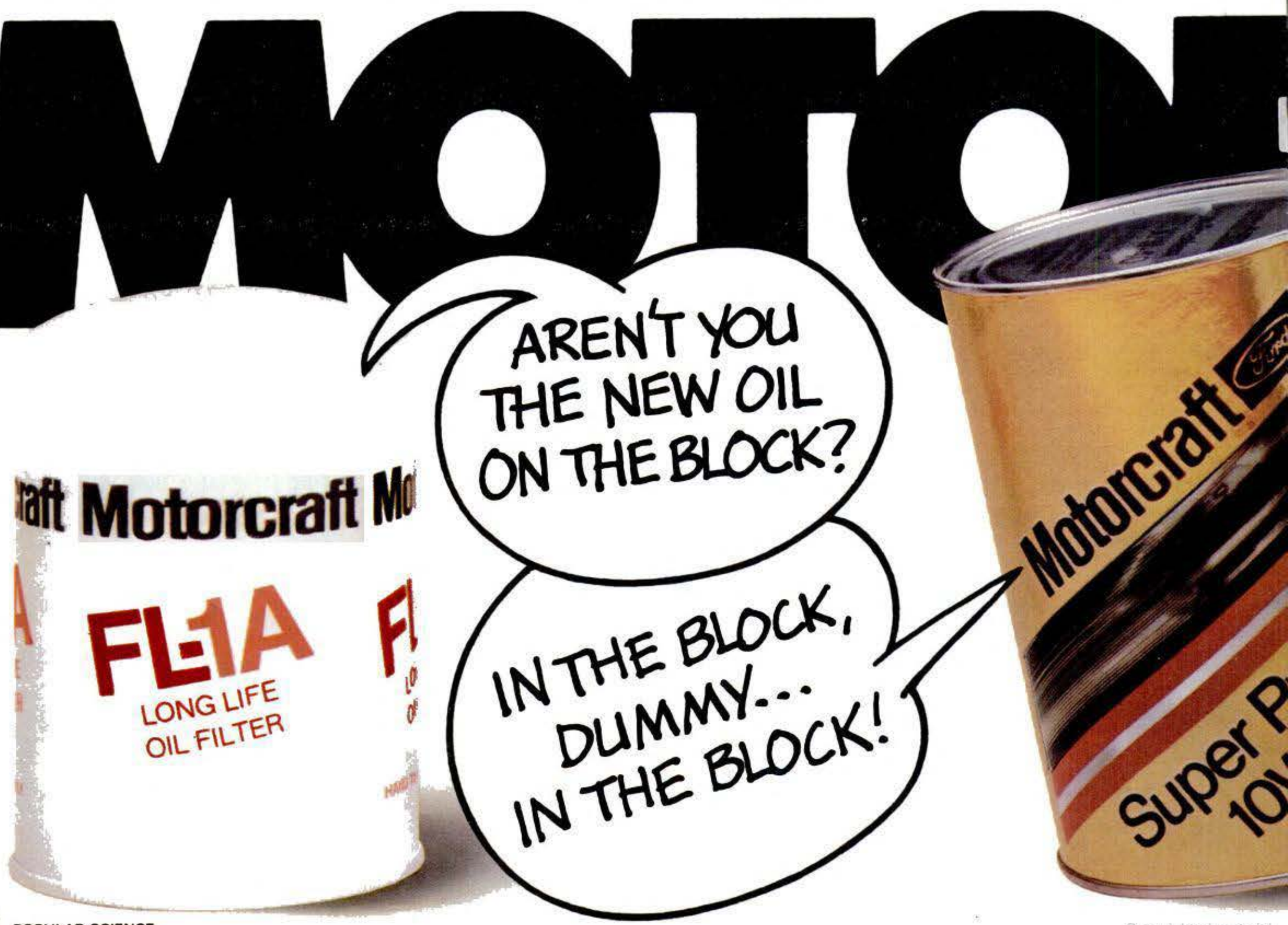
The dealer says the combination valve is okay and not adjustable, but I think that's where the trouble is.

Allan Lee Baker, St. Clairsville, Ore.

Check line pressure to the front brakes and to the rear brakes. I believe you need to increase rear line pressure to suit your wants.

Fuel-icing problem

Last winter my 1977 gasoline-powered Rabbit with CIS fuel injection stalled at temperatures below −5 deg. F. This would occur after driving for about 40 minutes at close to 60 mph. The problem was diagnosed as the fuel injection icing



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up, and the use of Drygas was recommended. I added the Drygas according to directions, but the next cold snap caused the car to die again. I was always able to restart the engine after letting it sit for a half hour. The heat from the stalled engine seemed to melt the ice in the system. Is there a better fix than Drygas? Does Drygas really do what it claims to do?

Roger Tirocchi, Cranston, R.I.

Hose some heat on the fuel system. That's the only real fix I know, except a fuel change.

Driving battle

My daughter recently bought a BMW 320i standard-transmission car and we started an argument on how to drive it.

My daughter insists that both the salesman and her friends told her this is a high-performance car, and one should keep the engine running at over 3000 rpm. As a result she is almost always running the car in first and second gear. She seldom uses third when the speed limit allows 50 km/h. She insists also that a friend who has the same car never drives higher than second gear in the city, and only in third and fourth when driving on highways.

I have test-driven the car and found it runs perfectly and smoothly from first to third at about 2500 rpm while driving at 50–60 km/h, and up to fourth gear at about 2100 rpm at 80 km/h.

I would appreciate your advice on the correct method of driving this particular car.

Paul Wong, Vancouver, B.C., Canada

Drive it in the highest gear it can pull without lugging the engine. I don't get the 3000-rpm stuff. A full-race engine, sure. But I assume this is an overrated, overpriced production engine.

Tire-wear problem

I have a 1978 Subaru 4WD station wagon. Although I think it is a fantastic car and wouldn't give it up for the world, it has one problem I can't get solved: The front tires wear very badly on the outside edges (especially the left one).

The car has been to two different dealers for a complete front-end check (at 11,000 miles and again at 25,000 miles), and each time I have been told that everything is at spec. I now have four brand-new Goodyear Tiempos (165 SR 13) and had to rotate them at only 100 miles (front to rear) because the front tires had very visible signs of wear on the outer edges. The original tires (Bridgestone mud-and-snows 155 SR 13) lasted 25,000 miles, but I had to rotate them every 4000 miles to get some even wear. All four tires were bald on the outside edge with safe tread everywhere else.

I have read that this tire wear is an inherent problem in some front-wheel-drive cars. [This model Subaru runs on front-wheel drive when the 4WD is not engaged.—Ed.] I had a 1974 Dasher that did the same thing, but other front-drive owners that I have talked with have had no complaints.

Richard Sheats, Export, Pa.

Try more toe-out, regardless of specs. If that doesn't solve the problem, you might try less camber.

About propane

In 1961 my high-school auto-shop teacher showed me the propane-gas conversion he had installed in his two-year-old Hillman. There was an adapter under the carb, a pressure-regulator valve, a dash-mounted lever that let you choose a propane or gasoline mode, and a 10-gallon tank in the trunk. It cost him about $50 to install, including the parts. He said mileage was about the same either way but that time between tuneups was unbelievably improved with propane.

As a salesman I drive a lot of miles every day in my 1978 Ford Fiesta (50,000 miles on it now, four-speed stick, standard four-cylinder engine). Ninety-five percent of it is highway driving and I average an honest 35 mpg. I'm paying about $1.30 a gallon for gas now and it hurts, so I've been considering converting to propane. It costs about 65¢ a gallon. But the least expensive estimate to do it (parts and labor) is $800, while most of the shops want around $1000. Even compensating for 1961 versus 1980 dollars, this seems way out of line. Has propane technology changed so much? What am I going to get for $1000? Is the investment worth it?

What do you think of the do-it-yourself kits advertised?

Jim Curran, Danville, Calif.

One thousand dollars is in the ball park. Why? Because of 1980 laws and prices. The technology hasn't changed. How can

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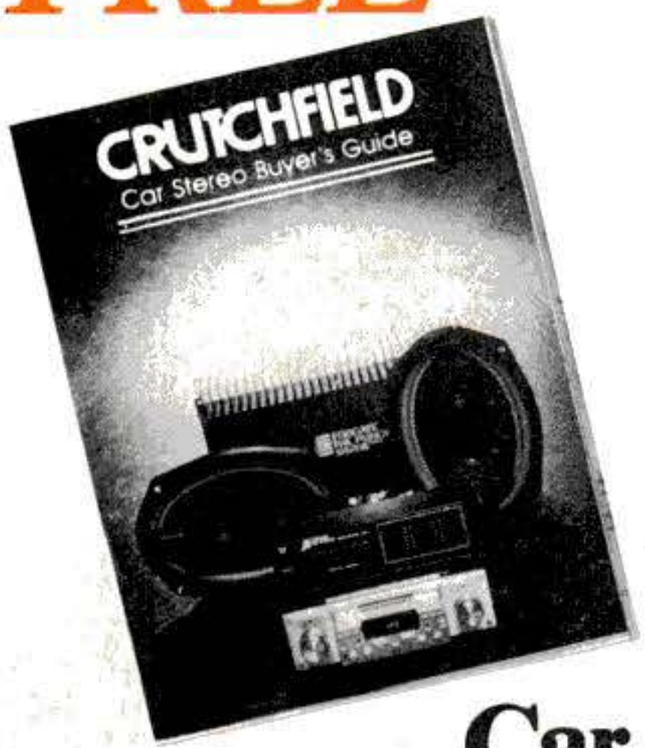

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"Say, Smokey—"

[*Continued*]

it? It's governed by laws of physics and thermodynamics that will outlast us all.

I don't think it's a good idea. The so-called low cost of propane is temporary. Supply will soon be limited and the price advantage will go. Also, expect a 10 percent drop in mileage. I agree that it's a good fuel. It's easier on engines and emissions.

Wants better gas/oil economy

I own a '79 Chevrolet Suburban ¾-ton, full-time four-wheel drive. The curb weight is approximately 6000 pounds. The 400-cu.-in. small block turns about 2950 rpm at 55 mph.

Since I bought this truck, I have been unable to get over 10 mpg, despite converting it to part-time four-wheel drive, advancing the timing to the point of pinging, removing the catalytic converter, and plugging the EGR valve.

Would headers—or just adding a second exhaust pipe—help? Or is this lousy gas mileage just something that I'm going to have to live with?

A second problem that I have been unable to solve is excessive oil consumption (one quart per 300 miles). Cylinder-compression tests reveal all cylinders to be above average, with no leakage. The valve seals have been replaced twice (the second time with larger, umbrella-type ones). What should be my next step?

Patrick Laughlin, Portland, Mich.

It ain't gonna change much, Pat. It's the same old story—poor mileage and high oil consumption. Overdrive it for a little relief or get your trading shoes on. It pushes lots of air, it's heavy, and it's geared low. Big engines just don't give good mileage. I disagree with your modifications, except part-time four-wheel drive. Also, your oil consumption is very high. I believe you have a cylinder-wall or oil-ring problem.

If you have big, wide, aggressive tread, that's costing you also.

A dipstick question

I have never been able to find out why automobile manufacturers do not "flare out" the top end of the crankcase dipstick sleeve. This slight modification would make the task of inserting the dipstick much easier. I suppose there is a good reason, but can you tell me what it is?

Burrows Sloan Jr., Charlotte, N.C.

Usually the stick has a dirt shield that pilots on the OD of the tube.

Hesitation fix

I own a 1977 International Traveler with a 304 V8 that tends to hesitate during acceleration. It does not do this all the time; but sometimes it will hesitate so badly that it is questionable whether it will take off from the stop sign. At about 8000 miles the dealer installed a new "black box," thinking this would solve the problem. It did for awhile. Any suggestions?

Fred Brown, San Gabriel, Calif.

The main reasons for poor acceleration are retarded timing or lean accelerator-pump shot. Check the timing under load (brakes locked, and in a lower gear) with a timing light that reads the actual timing. This won't help if the problem is intermittent and you catch it when everything is okay. The accelerator-pump shot can be measured in cubic centimeters with the carb off. Manifold heat valve should stay put and move in reference to temperature only. I doubt that could cause hesitation that would be very noticeable, anyway. Consider an older or newer ignition. That black-box deal won't ever win any engineering award.

Gasoline additive?

A few months back an article in our local newspaper recommended that automatic-transmission fluid makes an ideal gasoline additive for old or inactive cars. It stated: "It's cheaper than commercial additives and works just as well. Commercial additives are basically a light oil with coloring and perfume added to make them look different." Would you please give us your information concerning this?

Eugene W. Murray, Tucson, Ariz.

I agree a light mixture of one quart to 10 gallons might help stop an engine from rusting, but I'd prefer running a little into the carb air supply at a fast idle to the point of near stall for three or four minutes. Do this on the last start before a lengthy park job.

Resonating exhaust system

I own a 1979 Dodge Omni with 1500 miles on the speedometer. It has an automatic transmission. Since new, the car has vibrated slightly and creates a moderately loud resonant hum at about 42 mph, and also just prior to shifting into second and third gears.

I do not suspect the transmission or differential, since the noise also occurs if I rev up the engine when the car is in neutral. The engine runs quietly above 45 mph. The Dodge dealer tells me this is normal for a four-cylinder engine.

Could this hum be a resonance in the exhaust system or in the engine itself? Can it do damage in time?

Peter D. Visalti, W. Berlin, N.J.

I believe you are correct about the resonance, but I doubt that it will cause problems—unless cracks develop in the exhaust system. There's not much you can do. Muffler tuning and hanger brackets are all involved. It's a pretty touchy area at best, and takes lots of cut and try.

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

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New RV portable generators

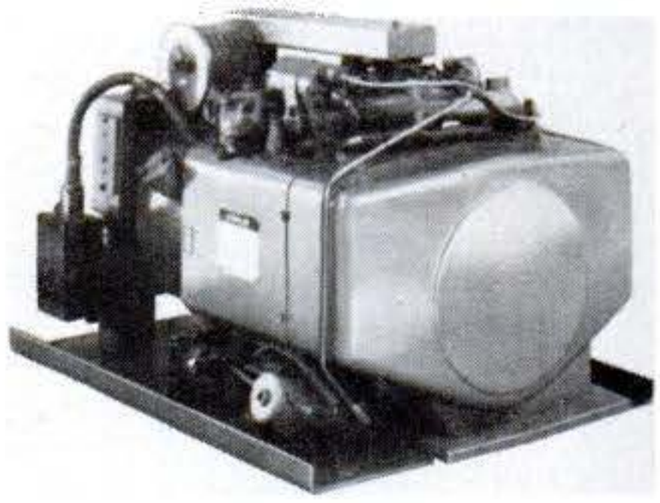
Yamaha's first generators for U.S. feature a DC outlet and large fuel tanks that give them a five-hour running capacity.

This year's generator news is highlighted by a new horizontally opposed, twin-cylinder engine from Kohler, and by the first Yamaha models to go on sale in this country.

Kohler's twin-cylinder 4.5-kW model represents its attempt to reduce the racket and improve the fuel consumption of big generators for recreational vehicles, while still keeping the weight low. Besides the inherent smoothness of the opposed-piston motor, this generator assembly is dynamically balanced at the factory—which adds up to quieter running, the manufacturer claims.

The two-cylinder concept is designed to be more fuel-efficient than a single-cylinder model with moderate-to-large loads. It will consume about ½ gallon per hour under normal loads. At 235 lbs., this generator is no heavier than the single-cylinder model it replaces, and that one weighed 100 lbs. more just three years ago. The aluminum engine block of the Kohler has cast-iron cylinder sleeves and camshaft. Weight reduction will continue to be an important factor as motor homes and travel trailers shrink for gas savings. Cost: about $1400.

Yamaha will offer three models with rated outputs of 1.2, 1.8, and 2.6 kW. All three have four-stroke engines, although Yamaha sells two-stroke engines elsewhere in the world. Each engine has transistorized ignition—which should minimize maintenance—and fuel-tank capacity for five hours' running. An automatic cut-off switch stops the motor when the oil level is too low. The 1.2-kW model will sell for $483, the 1.8 for $615, and the 2.6 for $794.—*Paul Bolon*



Kohler's 9.9-hp, twin-cylinder generator offers quiet performance, light weight.

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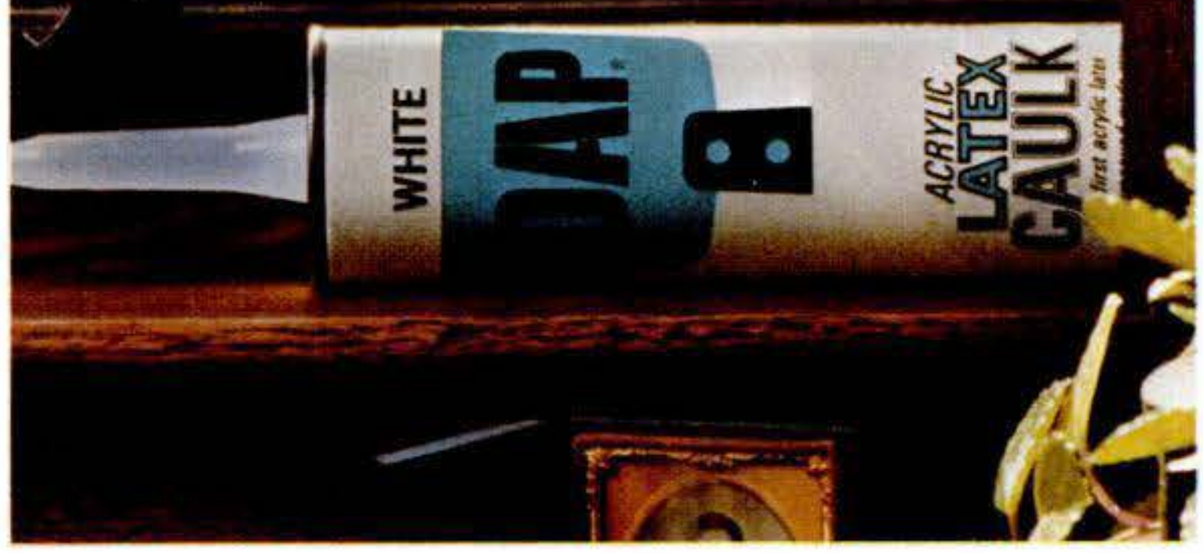
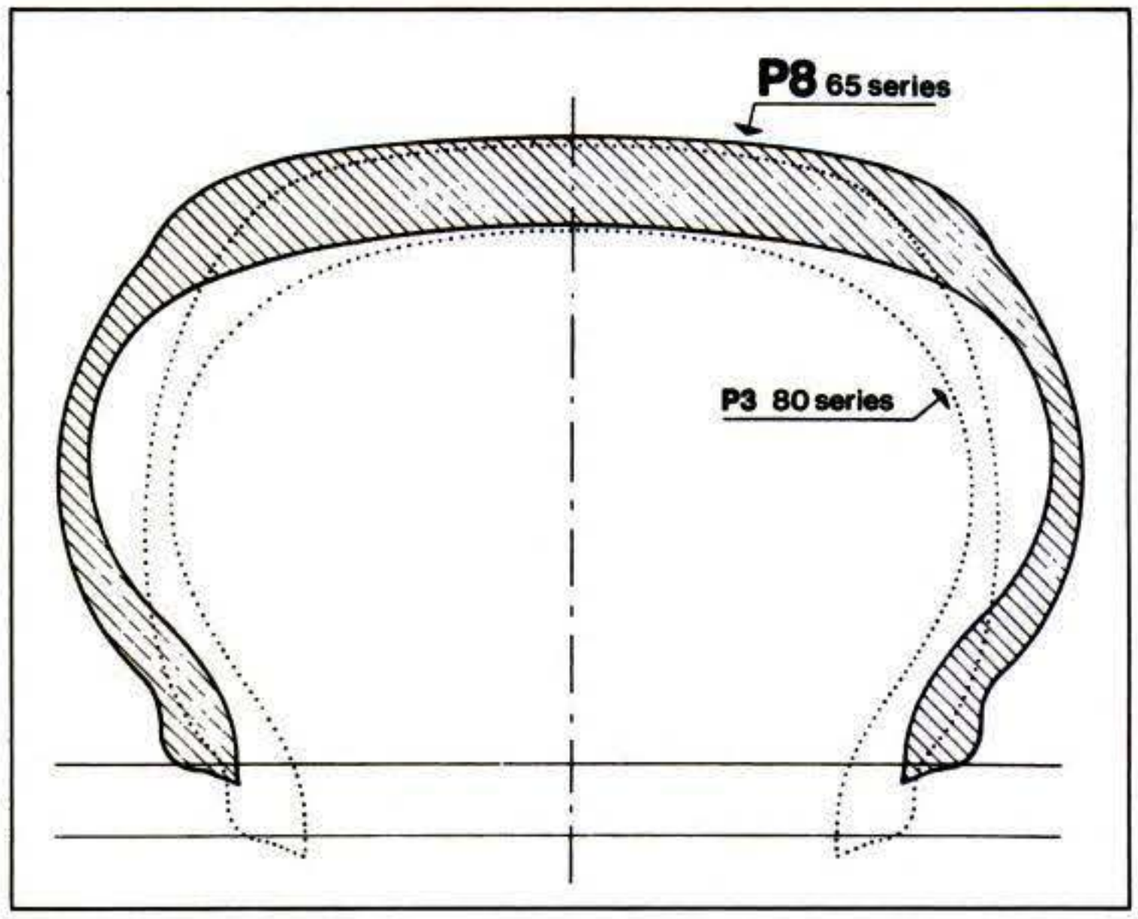


Italian tire maker says. Lastly, the P8's tread pattern, consisting of blocks with many transverse grooves, gives maximum longitudinal flexibility, reduces tread deformation.

Unlike other gas-stretching tires, which call for inflation pressures of 36 psi, the P8 is designed to run on standard inflation pressures of 24 to 28 psi. This makes for a more comfortable ride and better performance.

The P8 is an SR-rated tire, signifying it's built to travel at sustained speeds of up to 112 mph. About 45 percent of U.S. motorists now use SR-rated tires. If they all switched to the P8, U.S. oil consumption could be reduced as much as 30 million barrels annually, Pirelli claims. The new tire is now being tested by several European car makers and will be available on a small group of 1980 autos. "Widespread use is anticipated by 1981," Pirelli says.—*Herb Shuldiner*



From Italy: fuel-stretching tire

How would you like to get a bonus of four-tenths of a gallon every time you put 10 gallons of gas into your car? That's what Pirelli promises, in effect, with its new fuel-stretching P8 radial tire, recently introduced in Europe.

The tire's low-profile ratio, improved elastic materials, and tread pattern are the three factors that contribute to greater fuel economy and improved performance, Franco Bottasso, Pirelli's technical director, says.

The P8 has a 65 percent profile—the ratio of height to width (the drawing compares the P8's profile with that of a conventional radial). Bottasso claims the P8 has an optimum tire/weight load ratio. This means it can achieve a high load capacity. It also reduces tread deformation and contributes to the lower rolling resistance. Pirelli says the profile provides "excellent lateral stability and overall performance."

The new elastic materials produce less friction. This wastes less energy and also lowers rolling resistance, the

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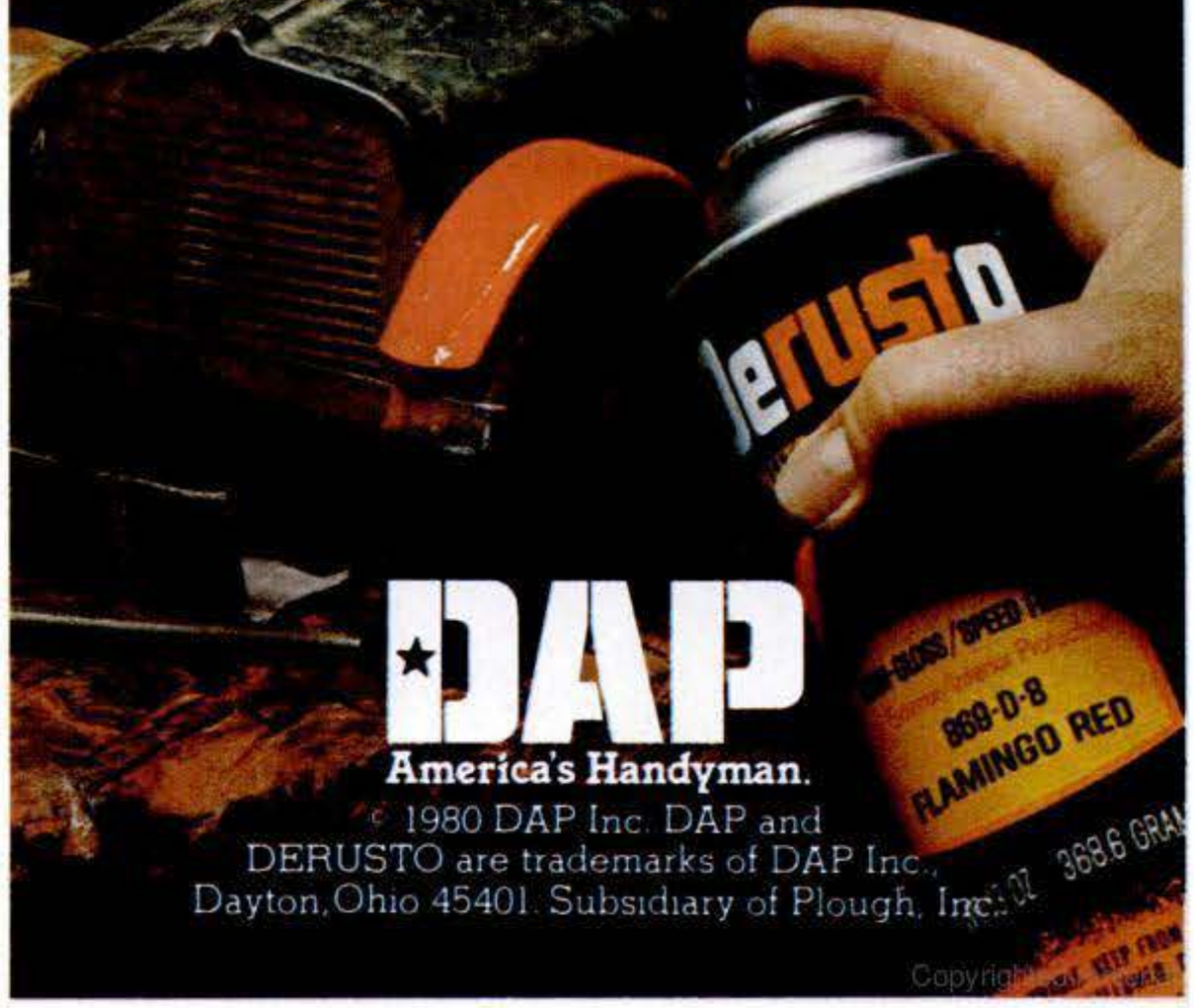

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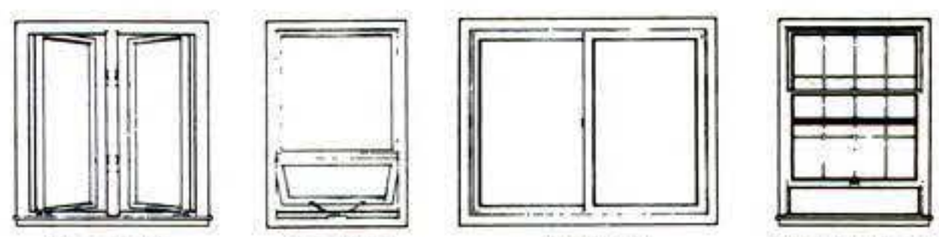

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Warranty:	1 year
Output voltage:	15KV
Ozone:	Less than 2 parts per billion
Dimensions:	5⅜" x 4¼" x 2⅜"
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Ion density:	Low to maximum of 540,000 ions per cm^3 at 1 meter. 1.6 x 10^6 ions per cm^3 at 50 cms.
Output voltage:	15KV
Ozone:	Less than 2 parts per billion
Dimensions:	11" x 5" x 4"
Use:	Large room or office 10,000 cu. ft.
Warranty:	1 year

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Curing summer ailments of **refrigerator-freezers**

By EVAN POWELL

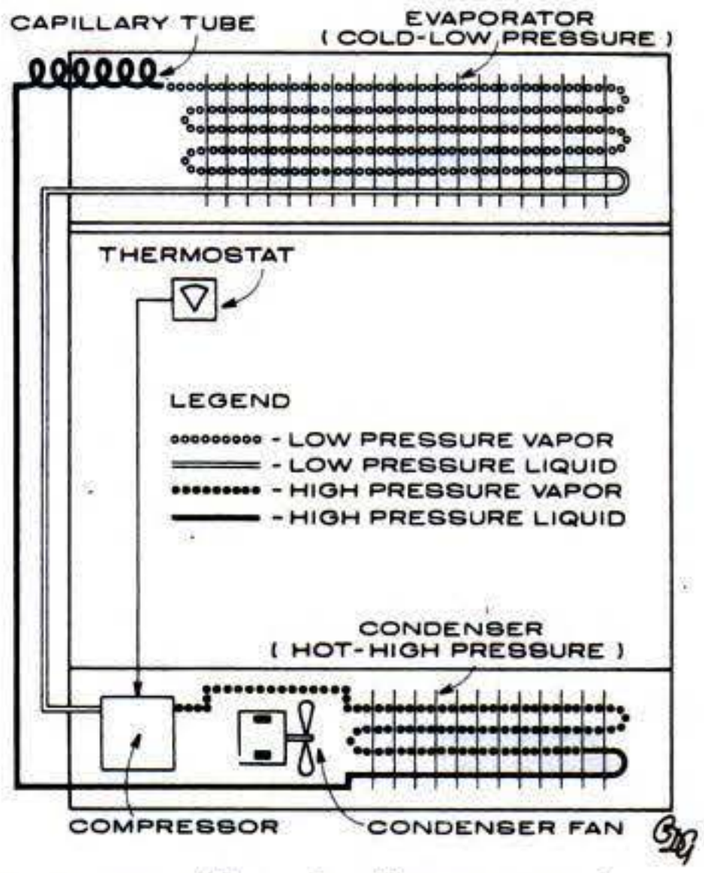
It's the biggest appliance in your house; yet, if you're like most people, you know the least about it.

Refrigerator-freezers do seem magical—huge empty boxes that somehow get cold. But when they don't get cold, you'll find the real trick is paying the repair bill. Fortunately, many problems are minor and don't really require an experienced technician. Most problems you can repair yourself—once you know the basics of the refrigeration system.

Basically, your refrigerator is a big air conditioner. When the temperature rises, the thermostat turns on the motor-driven compressor pump that forces a refrigerant through the coils. As gas, the refrigerant absorbs heat in the compartment when passing through the evaporator coils and gives it off to the outside air as it condenses back to a liquid in the condenser coils. It's a closed, pressurized system that generally gives you little trouble. When it does, however, you'll have to pay for a professional house call.

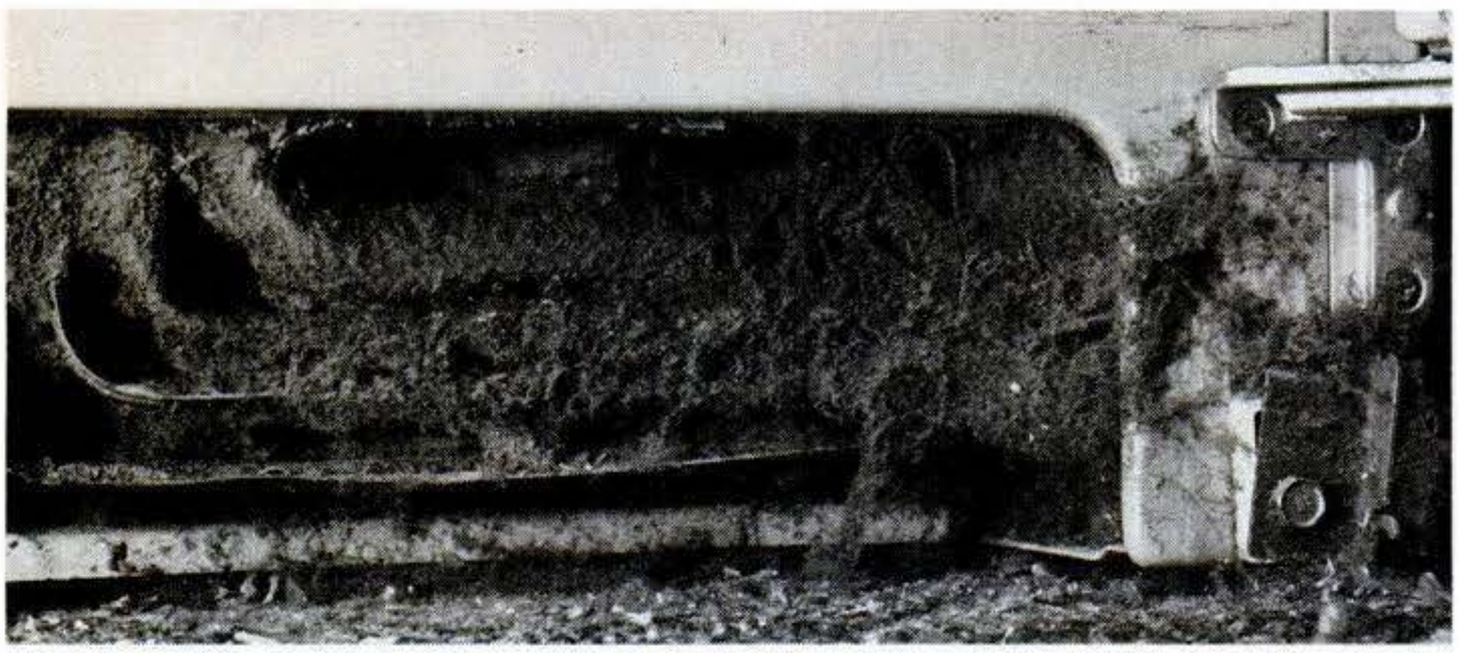
It's the support components—thermostats, motors, seals, etc.—that normally break down. But in most cases, you can repair them yourself with the aid of instructions in the series of boxes on these pages.

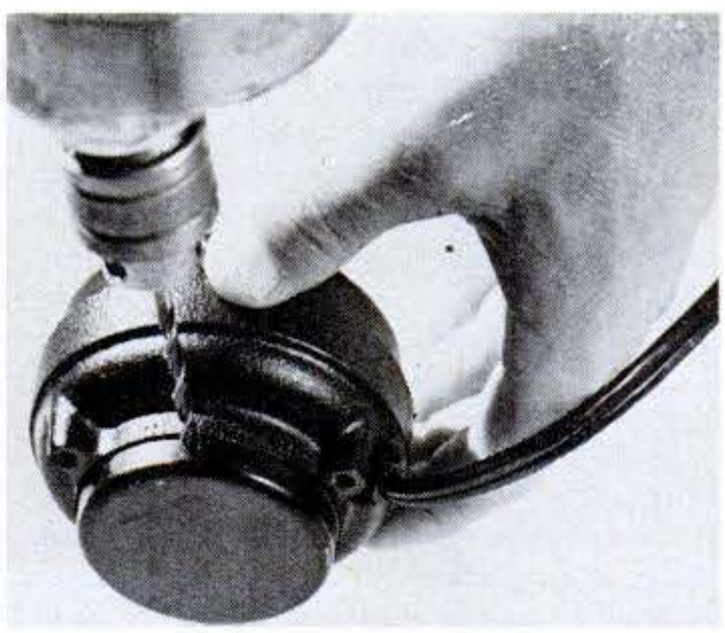
As with any appliance repair, however, be sure all power is removed before you make tests or repairs.



For more on refrigerator-freezer repair, see following pages

Check external causes first





Use your eyes and ears to pinpoint problems. If the fridge is not running at all—absolute silence—open the door to see if the interior light comes on. If not, there's probably no electrical power reaching the fridge. Check the AC cord for breaks, the plug and wall outlet socket for loose contacts. They can be damaged by pushing a refrigerator too far back against the wall.

If the refrigerator is running, but not cooling, check the condenser for dirt. The finned tubes are underneath or at the back of the refrigerator, depending on the model. Air must circulate freely through the condenser coils for cooling; dirt and lint can build up, restricting that flow in a relatively short time. Clean it carefully with a vacuum and soft brush attachment. And clean it routinely—once a month. A plugged condenser can cause the compressor to overheat, creating internal damage if left unattended.

Condensers mounted underneath the refrigerator depend on a small fan motor to force air through them. If the shaft is bound up, you may be able to save it: Drill a small hole in the rear metal housing and add about 20 drops of oil to saturate the wick. Pull the motor shaft in and out until it's free. Naturally, if this doesn't work, replace the motor.

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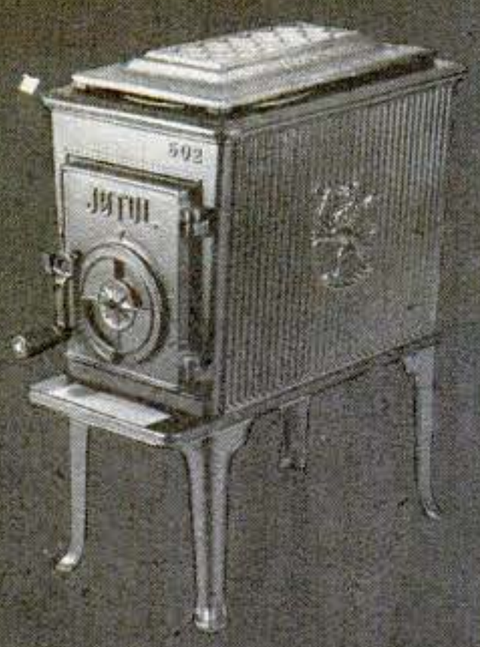

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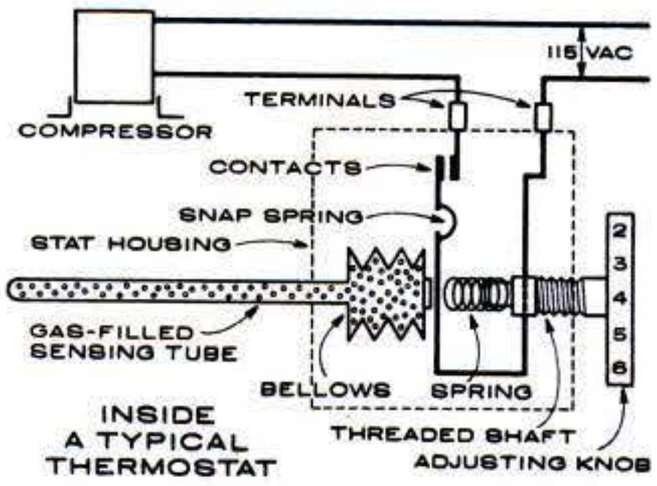
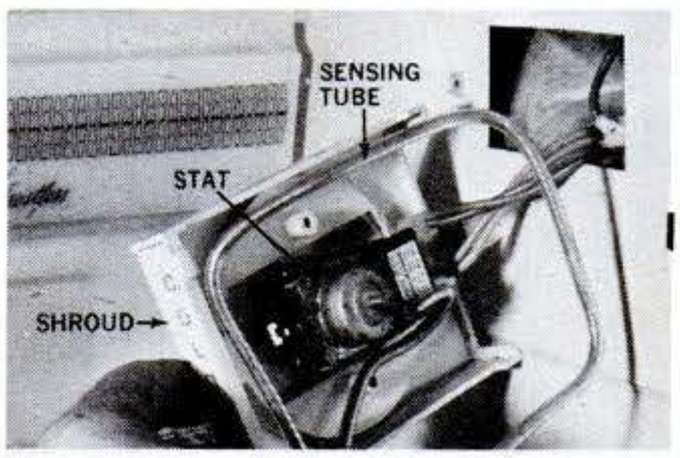
Testing the thermostat



INSIDE A TYPICAL THERMOSTAT



While some thermostats merely open a damper to admit cold air from the freezer, most are temperature-controlled electric switches. The switch contacts, located under the thermostat temperature-range knob, are mechanically linked to a sealed tube that contains a gas. As the temperature within the refrigerator warms, the gas in the tube expands and exerts pressure against a flexible metal bellows in the thermostat. This causes the thermostat switch to close, turning on the compressor. When the interior cools, the gas contracts, allowing the thermostat contacts to open.

If the cooling cycle will not start, first visually check the tube for breaks or kinks. You can test the thermostat with an ohmmeter (VOM). First, unplug the refrigerator, then remove the screws that hold the stat in place and remove either one of the wires from its terminal. Then turn the knob to the coldest position and hold the sealed end of the sensing tube in your hand to warm it. With the VOM set to R×1, the meter should read continuity (0 ohms) across the switch terminals.

If the interior gets too cold, the thermostat may not be opening. First check that the end of the sensing tube is securely clamped to the evaporator. Test the thermostat with the VOM connected as before and turn the knob to the warmest position (assuming that the sensing tube is cold). The VOM should show no continuity (infinite resistance). If the stat fails either of these tests, it must be replaced.

There's a trick to installing the sensing tube in models that route it behind the cabinet to where it's clamped to the evaporator. (Check this before removing the old stat.) If it's not accessible, tape a wire or string to the end of the old thermostat tube and use it to pull the new one into position.

Continued

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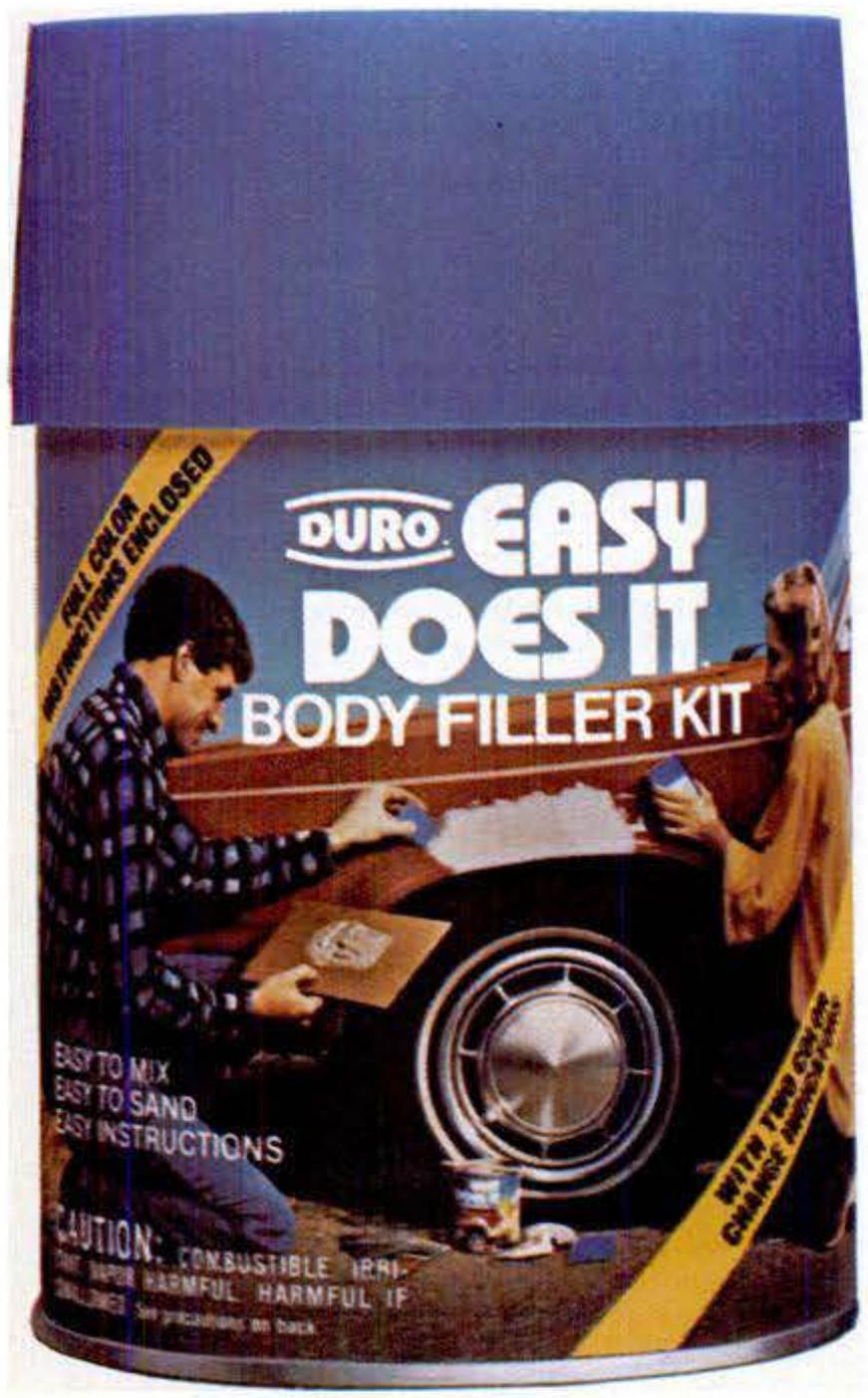

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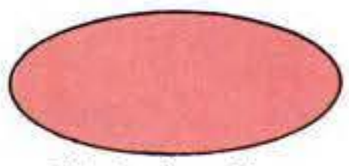

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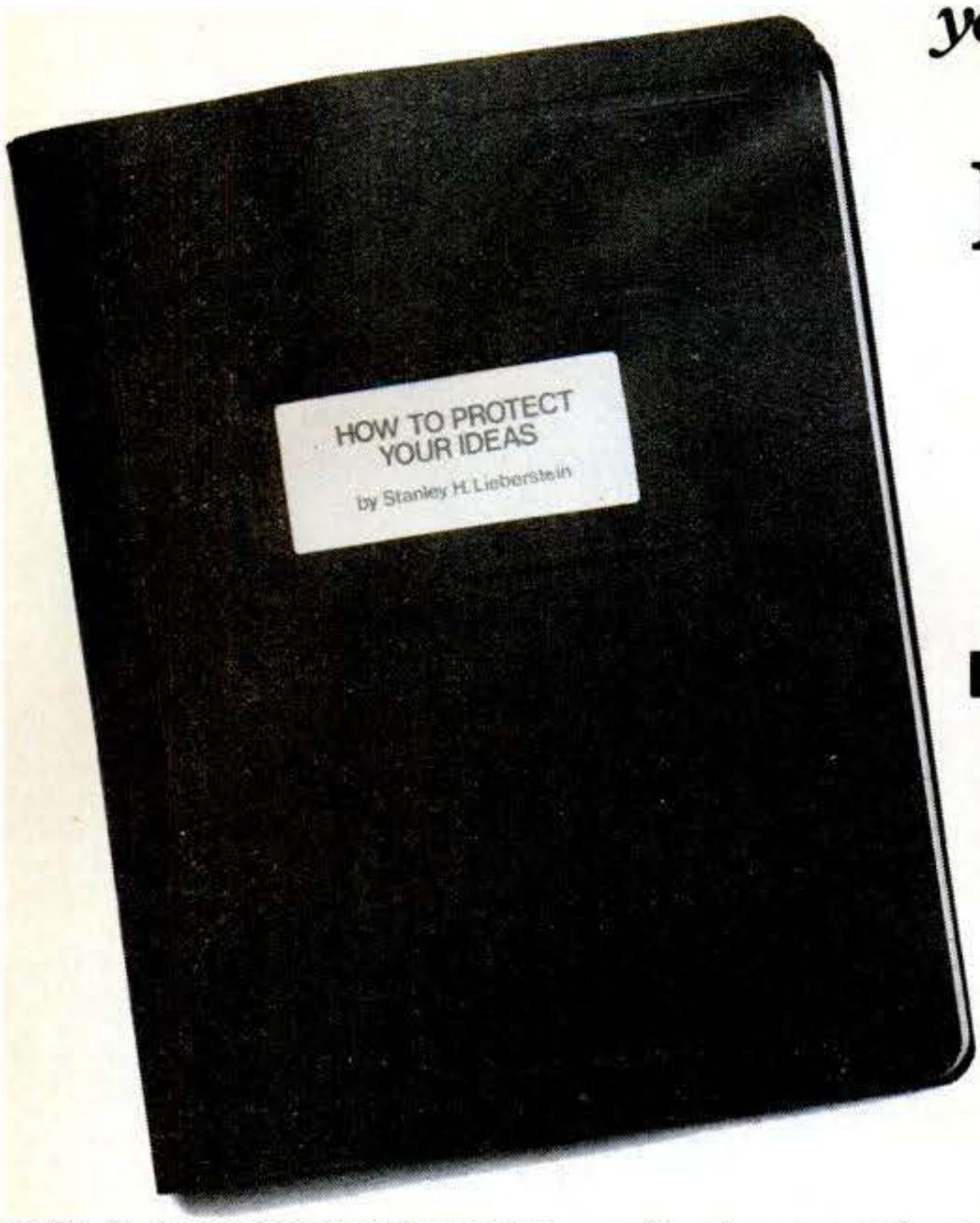

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by Stanley H. Lieberstein, Esq.

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Author Stanley H. Lieberstein is a New York attorney specializing in patent, trademark, copyright infringement and trade secrets law. Former assistant and technical adviser to the U.S. Court of Customs and Patent Appeals, Mr. Lieberstein has also served as an examiner in the U.S. Patent and Trademark Office and as general counsel to a subsidiary of Occidental Petroleum Corporation. He is presently a member of the Board of Directors of the New York Patent Law Association and is listed in *Who's Who Among American Lawyers.* A recognized authority in the field, Mr. Lieberstein publishes frequent articles and conducts seminars for business and industry.

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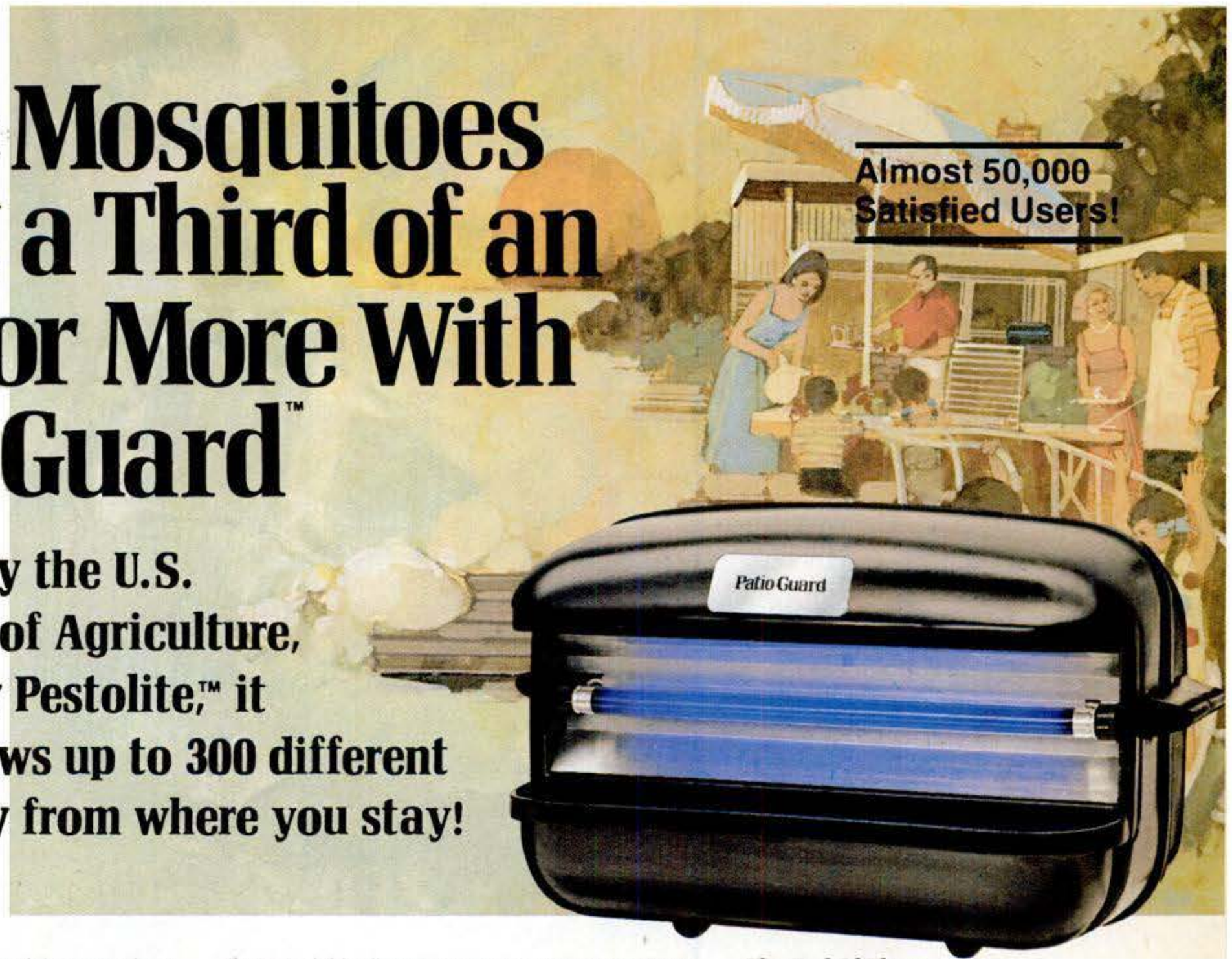

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Naturally, this government research was public property. But there were problems that remained to be solved. What the U.S.D.A. had shown, beyond doubt, was the fact that light sensitive, phototropic, insects would always respond to a particular kind of ultraviolet light. More, that the lure of the light extended far beyond the supposed ability of these insects to see. At the very minimum, insects were attracted by the light over as large an area as 1/3rd of an acre—14,250 square feet!

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The light attracted. But it didn't kill the insects. This is where Pestolite stepped in and created a simple, totally foolproof, completely safe and silent way to get rid of every bug attracted to the light, killing without chemicals, without polluting the environment, or without electrocution.

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Pestolite's achievement is notable in other extremely important ways. The other companies that used this discovery came up with bug killers that are no more effective; in fact, ignore the peskiest ones and electrocute the other insects with a popping sizzling sound. And their units sell for $125.00 and $150.00 more.!

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Patio Guard mounts in minutes, virtually anywhere. On a tree, any kind of fence, the side of your house, even a brick wall. Set it up about 25 feet from where you generally stay. Fifty feet may be even better. Then plug it in. Ordinary house current is all that's needed, though you may have to use an extension cord. The operating cost is less than 30 cents a month.

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Just why it works no one knows. Not the scientists who developed it, not the entomologists who tested and confirmed the phenomena. They do suspect, however, that the light's effectiveness is somehow connected with the constant early evening and night time propagation (sex) activity of these insects.

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Captured, unable to escape or fly away, the mosquitoes, moths, gnats and other insects are caught in a down-draft (created by a small electric fan) and plunged into the water in the pan below where they're drowned. All you do is change the water about once a week, emptying the tray in the bushes where the birds eat all the bugs. It's a clean, simple, seconds-a-week procedure.

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So, get the gang together and talk to your GMC dealer about buying or leasing a GMC Rally Wagon.

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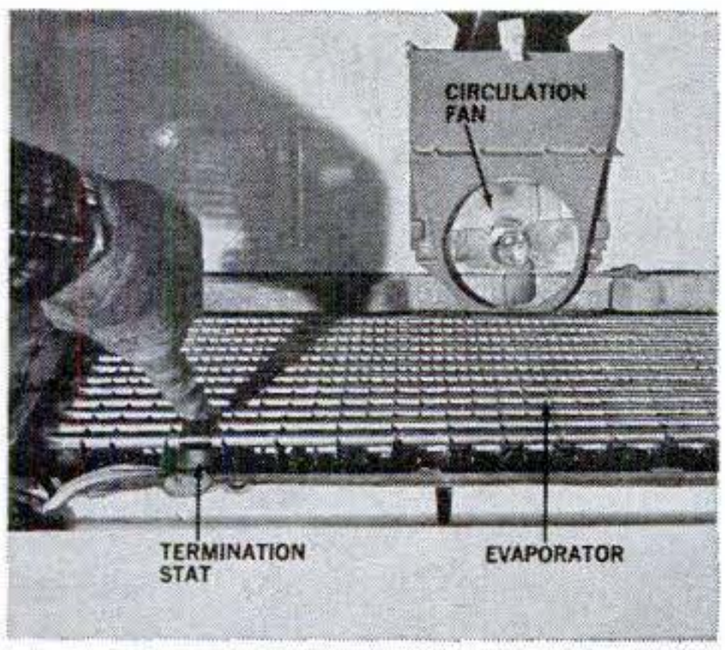
Testing the "frost-free" system



There's really no such thing as "frost-free" refrigeration ("hidden frost" would be a better term). In so-called frost-free models, the cold evaporator coil is in a hidden compartment. A small fan circulates air across the coil and into the interior of the refrigerator. The evaporator still must be defrosted—most have a heater for this purpose—but you never see the water that's produced.

In the defrost cycle, which occurs at set intervals during the day, the circulating fan and compressor are disconnected from the circuit. The defrost heater and drain-pan heater are then energized to melt frost from the coils and heat the trough that carries the water away. It goes to a condensate pan located beneath the unit compartment where it is evaporated into room air.

While the timed defrost period lasts about 20 minutes, a termination thermostat turns off the heater long before that. This stat is tightly clamped to the evaporator coil. When the temperature rises to a preset point above freezing, the stat opens and disconnects the heaters.

Problems in the frost-free circuit compound themselves—frost buildup can fill the space between the evaporator fins so air can't pass. Added result: no chilled air flows into the food compartment.

The evaporator is usually located on the back wall or beneath the floor of the freezer compartment near the interior circulating fan. Look at these areas closely for signs of frost buildup. If you can see it on the outside of the panel, there's a lot more beneath it.

The defrost timer is the most likely cause of frost buildup. It is usually in the unit compartment, although it may be in the refrigerator section or mounted on the back of the refrigerator. Most have a small synchronous motor that can be viewed through a transparent window in the back. If the motor is not turning when the refrigerator is plugged in, unplug it, snap the motor cover off, and check for dust, dirt, or damage.

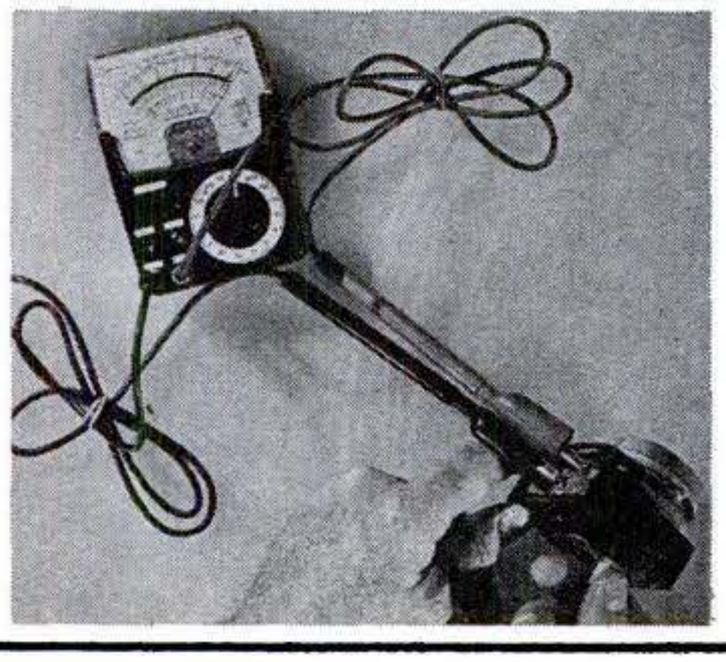
If the motor is running and the timer turns, check the switch section with a VOM. (The wiring diagram should indicate which switches are closed during the defrost cycle.) Advance the timer knob to the defrost position (you can hear it click) before testing, and remove one wire on each set of contacts before checking for continuity. Many timers can be disassembled and inspected visually by removing two screws from the cover plate.

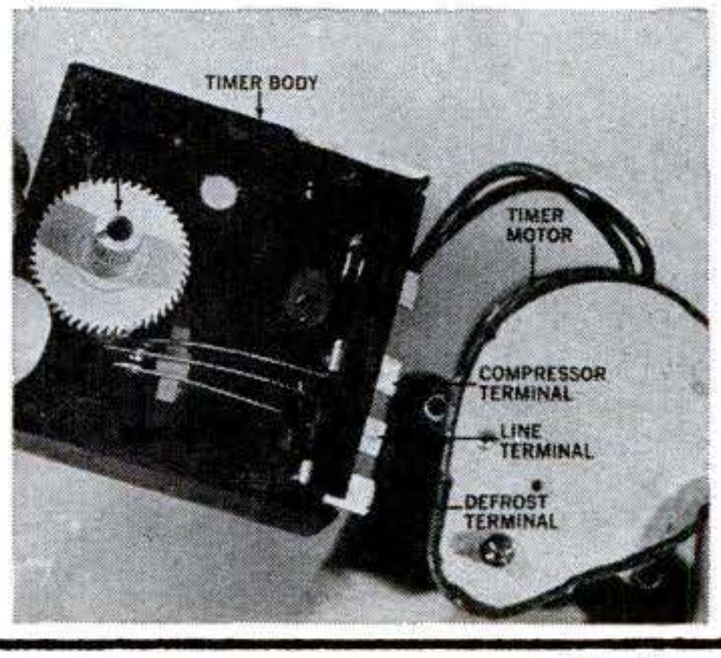
The defrost heating element is easy to test with the VOM once you reach the heater leads. The wiring diagram should show a particular color code for those wires. They often run to a point in the unit compartment beneath the refrigerator or behind the trim strip in the front of the compartment. Disconnect one wire and test the heater with the VOM using the R×1 scale. It should indicate continuity. Next, switch to the highest resistance scale and check from each lead to the metal cover of the heater. There should be no continuity. A reading here indicates a grounded element.

If the defrost heater is simply clipped in place in front of the evaporator, you can change it just by unclipping it and snapping the new one in place. If it's embedded in the fins of the coil, call in a pro; it's not worth the risk of damaging or kinking the delicate tubing.

The drain-trough heater is tested like the evaporator heater. The new one should be installed in good thermal contact with the trough.

Termination-thermostat troubles are difficult to diagnose. Your best bet is to check the other defrost components first; if they are okay, replace the termination stat by removing it from its clamp and installing a new one.





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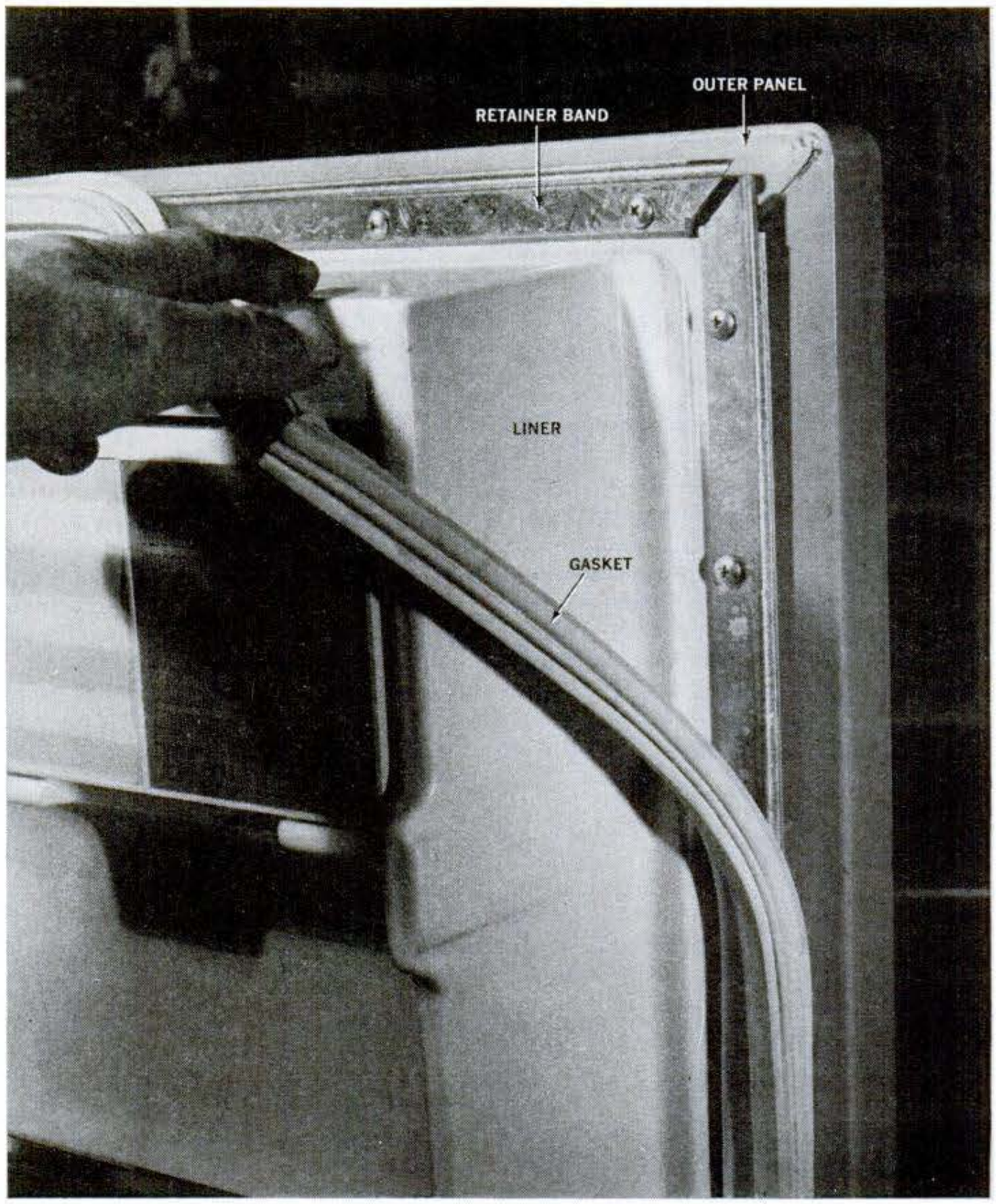
Gaskets, doors, and trim



If excessive moisture forms on the interior of the cabinet, it is probably caused by a defective door gasket or other opening that allows moist, outside air to enter.

The gasket is critical since much of the door sealing depends on the magnetic strips embedded within it. To test it, close the door on a one-inch strip of bond paper. A slight tug should be felt as you pull it away. Try it at several locations around the door.

Damaged or deteriorating gaskets can be replaced by removing the door-liner screws. (Some models have a metal band with a lip to hold the gasket; you need only loosen the screws.) Before installing a new gasket, remove it from the carton, spread it out to its approximate shape, and allow it to sit at room temperature for about 24 hours. Once the gasket is installed, it may take a week or so for it to adapt to the proper position.

Doors can become slightly warped if tugged sharply from a corner, or if the refrigerator is moved. Don't panic. To realign a door, level the cabinet by adjusting the rollers or feet, then lift the door gasket and loosen the screws which hold the inner door liner to the outer panel. Twist the door gently back into position and tighten the screws until they are snug.

Damaged molding trims that separate the interior of the cabinet from the liner can be replaced by first warming the trim with a warm, wet cloth. Then push the trim gently away from the cabinet using a small putty knife. Finally, pull the trim straight out from the compartment liner. The new trim just snaps into place in the reverse order.

Decorative trim will vary according to the model fridge you own. But, in general, damaged pieces can be replaced—or straightened—fairly easily.

The plastic studs that hold shelves and drawers in place are easily replaced. Some have a screw to hold them, but many have a twist-lock device. To remove this device, twist it clockwise with pliers. After about a quarter turn, you should be able to pull it free. The new stud is inserted into the slot and turned until it snaps into position.

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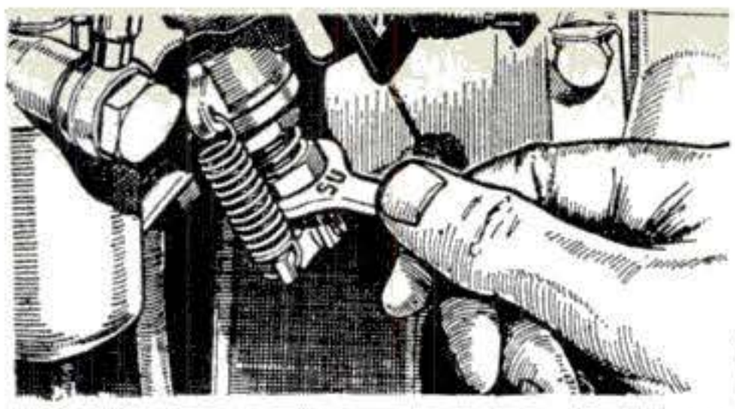

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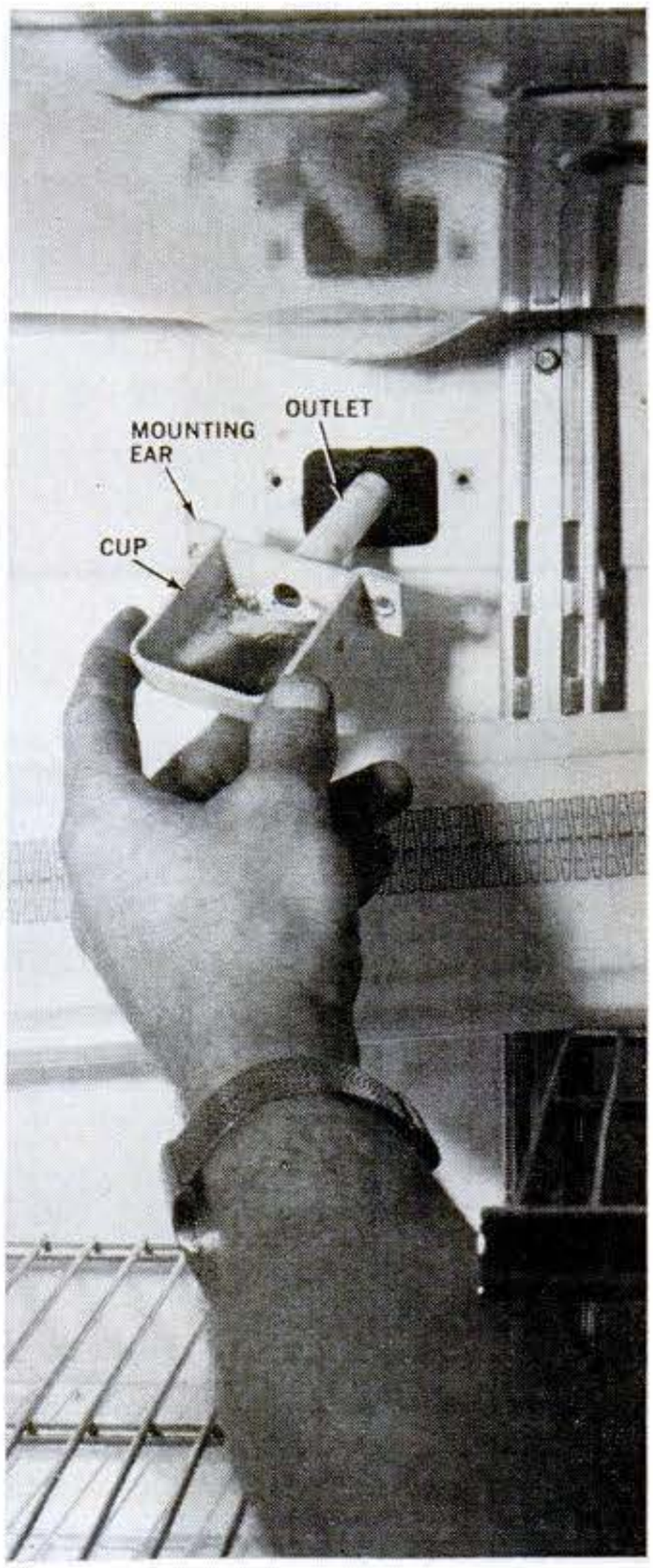

After a running cycle, frozen droplets of water along the evaporator coil will begin to melt. Normally, they will run down the coil surface and leave the compartment through the drain trough. If water collects in the bottom of the refrigerator compartment, however, contaminants along the coil may cause the water to drip off before reaching the trough. If this occurs, wash the coil thoroughly with a mild detergent, then wipe on a solution of water and dishwasher wetting agent. Don't rinse it off; the wetting agent will help water run off the clean coil.

If the drain trough is overflowing, remove it and the connecting drain tube that leads to the condensate tray in the unit compartment. The tube is usually located on the back of the refrigerator. Clear the tube by forcing water (from a faucet) through it. You'll probably force out a "plug" of algae or food particles. Use a pipe cleaner to clean the trough outlet. After reinstalling, pour a tablespoon of ammonia into the drain trough to destroy any spores and prevent further algae growth.

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Ten tips for better boating mpg

As gasoline prices continue to soar, power boating becomes more and more costly. Here are 10 tips to help conserve fuel afloat.

- Make sure your engine matches your boat. The engine should be powerful enough to plane your boat, passengers, and gear even at throttle speed reduced up to 25 percent. A large engine working easily may actually use less fuel than a small engine stretched to its limits to maintain speed.
- Pre-season, mid-season, and post-season maintenance, as specified in your owner's manual, is essential for top fuel mileage. Clean and properly gap the spark plugs; correct the idle and choke adjustments.
- Keep the bottom of your hull clean. Algae growth or barnacles retard performance. Anti-fouling paints discourage these parasites from hitching a ride on your boat, and make the hull easier to clean.
- Rig your outboard as high on the transom as possible to minimize drag from the engine's lower unit.
- Make sure your engine is properly aligned with the boat. Some outboards have a trim tab that's adjustable to compensate for propeller torque. The vertical angle of the engine must also be adjusted so your boat neither plows nor porpoises.
- Get on plane quickly. Your engine works hardest and uses extra fuel when first getting on plane. Quick acceleration minimizes this hard labor.
- After you've reached a solid planing attitude, throttle back as far as you can and still maintain a clean plane. In most cases, a 20–25 percent reduction in throttle setting saves 20–50 percent on fuel, depending on boat and engine combination.
- Don't idle unnecessarily. Today's outboards need no warm-up time.
- Drive straight unless there's a safety reason for varying direction.
- Be sure to use the correct outboard oil. Most newer outboards run on a lean 50:1 ratio of gasoline to oil, but many older models operate on a 24:1 mix. Check with the manufacturer for the mix for your engine.

Careful refueling is also essential; don't spill. And while squeezing the bulb on your fuel hose, watch for any leaks in hose or connections. Leaks are wasteful—*and* dangerous.

These tips are adapted from Johnson Outboards' *Guide to Fuel Conservation.*—*Ed Moslander*

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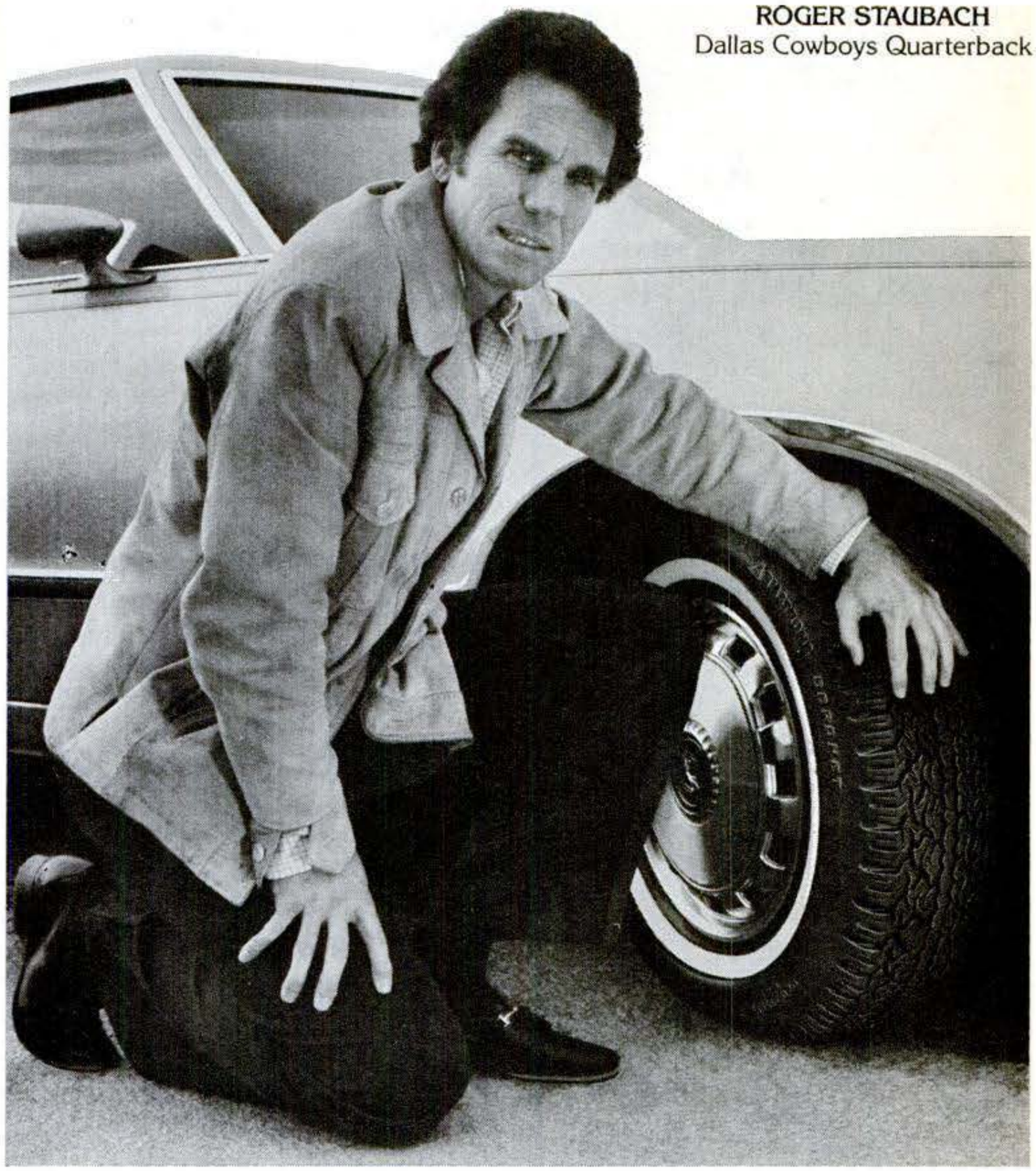

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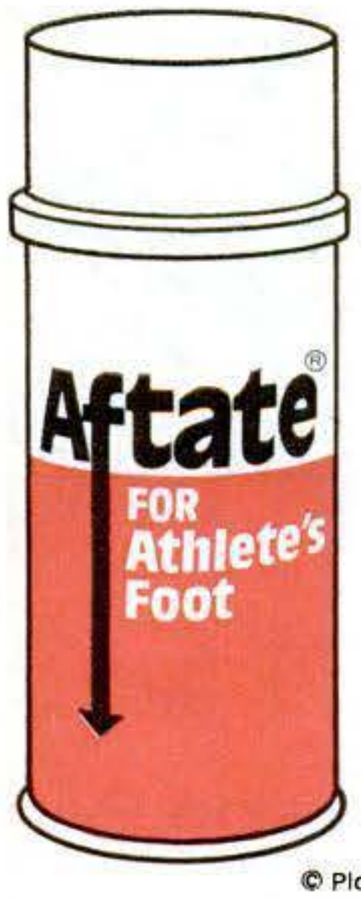

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HOUSEPOWER CLINIC

By EVAN POWELL

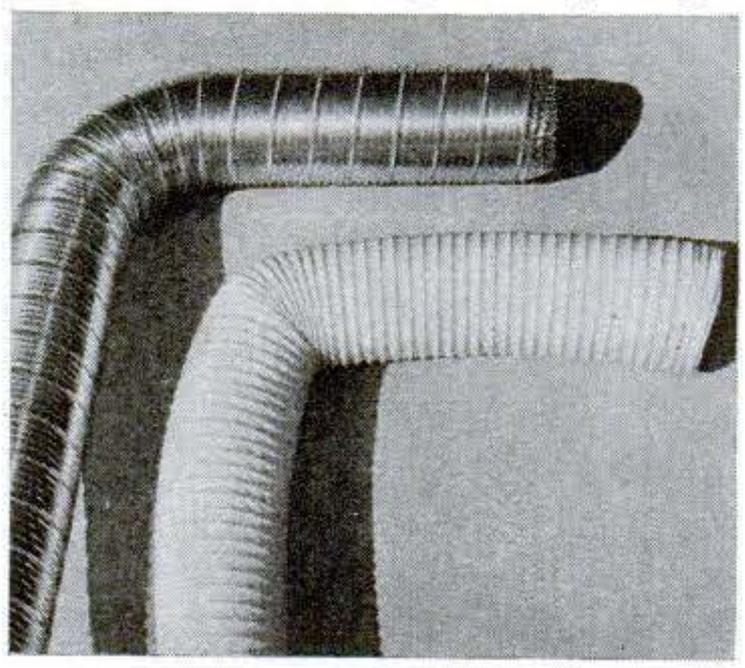
Dryer-venting danger

If your clothes dryer is less than 10 years old, it is probably vented through a flexible plastic duct. The same kind of ducting is supplied with the do-it-yourself venting kits that are displayed in most appliance emporiums.

Even so, the instruction manual of my new General Electric dryer says, in capital letters: "WHEN FLEXIBLE DUCT IS USED, WE STRONGLY RECOMMEND METALLIC FLEXIBLE DUCT."

Several top officials of the appliance industry I talked to recently expressed concern about nonmetallic ducting. And I must say, I agree with them.

Here's the problem. No matter how well the vent system is installed, there's always some lint accumulation in it and in the air passageways within the dryer. Lint from many fabrics is highly flammable, even somewhat explosive in certain proportions. If it ignites—and it probably will sometime—a "flash" occurs that can momentarily spread through all the passages



where lint lurks. If it's contained within metal enclosures, that's usually all there is to it. Not so when nonmetallic duct is used; the duct itself can burn and melt, causing, at the least, severe smoke damage.

If your dryer uses plastic duct, I think you would be wise to convert to metal, either rigid or flexible. You may have a tough time finding metallic flexible duct, but check with appliance-parts suppliers or heating- and air-conditioning-parts dealers. Flexible duct is quick and convenient, but remember that it offers more air resistance and for this reason should not be used for runs of more than 10 feet in length.

While you're making the change to metal you might also consider installing one of the devices that allows you to exhaust heated, moist air indoors during winter months, and outside in summer. Several studies, including my own [PS, Nov. '78], indicate that this is an inexpensive and beneficial energy saver.

Water-heating dishwasher

In most dishwashers, the heating element that dries the dishes is also energized during the wash cycle to maintain temperature while the water is sprayed on the dishes. It may even raise the temperature a degree or two. That's enough for normal conditions, but not if you've lowered your water heater setting, as I have, for safety and energy conservation. To boost the temperature of the hot water, I installed an in-line water heater.

Now, KitchenAid has introduced the Energy Saver IV dishwasher, which includes a built-in heater that boosts water temperature as high as 150 degrees for the first and final rinses. This lets you keep your water heater set at 120 degrees, which can mean a 10 percent saving in water-heating costs. This new dishwasher also has a switch that lets you eliminate the power-drying cycle—as do other dishwashers touted as energy-savers. But designing a dishwasher to operate with 120-degree water is a welcome innovation.

Q&A Finding hard-to-get parts

I service home appliances, and I have been unable to find a part for a Hardwick range model Z4642A-41AT, purchased in 1966. I removed a block containing a defective oven thermocouple and took it to a dealer, who said he could get another; then I was told he couldn't get the part and had thrown away the old one.

Arthur Hoewing, Moweaqua, Ill.

Functional parts are usually available for older appliances—somewhere. Your letter is typical of many I receive. I find good success by following this procedure:

- *Start with complete identification—the full model and serial number taken from the model-number plate, not the owner's manual or a sales slip.*
- *Inquire at the authorized repair center or an appliance-parts distributor.*
- *Write or call the manufacturer.*

One of these actions will almost always get results. In your case, Hardwick advises that the part is available through Robertshaw (the controls manufacturer) as part no. VS 4060-005. Your local dealer is Robert Barclay, Inc., 730 E. Sangamon St., Decatur, Ill. 62521; tel. (217) 428-6601.

Capping the chimney

I have a brick fireplace with a Heatilator built into it. When it rains, water comes

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down the chimney. Would an extension with a hood installed at the top of the chimney prevent this?

G. D. Scharnhorst, Sacramento, Calif.

A terminal cap for the chimney can stop this problem and prevent downdrafts as well. This can be as simple as a flat piece of sheet metal supported by four legs; but, when using a manufactured fireplace, use the cap recommended by the manufacturer.

Dishwasher drying tactics

After reading about ways to conserve electricity, I disconnected the heating element on my Sears dishwasher, model 587.721501. This caused the soap dispenser to become inoperable, so I reconnected it. Is there any way to eliminate just the drying cycle?

Robert Fox, Addison, Ill

First, drying the dishes isn't the only duty of the heating element. It also maintains water temperature during the wash cycles, and disconnecting it can leave you with a tub of dirty dishes.

Unless a dishwasher is equipped with a switch that stops the machine at the end of the final rinse (as later versions of your model were), there's no good way to accomplish this except to turn the machine off as soon as it reaches the dry cycle. At the same time, open the door to promote air drying.

Better take another look at that soap dispenser; disconnecting the heating element shouldn't keep it from working. This is a bimetal type dispenser, and I suspect that you may have a poor connection where the wires enter the dispenser. Sears has a modification kit to correct this.

Refrigerator condensation

The sides, door, and top of my GE TB14 refrigerator-freezer are cold to the touch. On a humid summer day there is condensation on top. Is it wasting energy? Should the shell have better insulation, and can I add some?

Richard Fitzpatrick, Brooklyn, N.Y.

If the condensation is only occasional and not enough to be troublesome, it's probably normal. No insulation is perfect, and it's zero degrees inside that freezer, just a few inches away from the cabinet shell. On a humid day, the dew point can be so high that only a slight temperature drop on the cabinet surface can precipitate (pardon) this problem.

If it gets worse, check for wet insulation by removing the plastic molding trim just inside the freezer door. To snap it out, first warm it with a cloth soaked in warm water, then pry gently with a putty knife. Some refrigerators have heaters to warm the cabinet and prevent condensation; yours doesn't have them, and it's just as well—they really waste energy.

Measuring power efficiency

In the May 1979 PS, you stated that you used a recording wattmeter to measure power consumption. Where can I get such a meter, or could I build my own? Also, where can I get a suitable switch for my 220-volt hot-water heater so I can turn it off and on without having to pull out the fuses?

James T. Boyle, Dothan, Ala.

Most industrial electronics suppliers can obtain or order a recording wattmeter for you, but they are expensive. It wouldn't be practical to build your own. Depending on your purposes, however, you might be able to use a recording kilowatt-hour meter, which is much more common (the electric meter on your house is a kWh meter). You might even find that your local utility will cooperate by selling or lending you one.

Any 30-ampere double-pole disconnect switch should be suitable for switching your hot-water heater. They are available from electrical-parts suppliers.

Orifices in storage

Where can I find an orifice to convert my Roper Model 52D13NN gas range from city gas to LP? Also, do I need anything for the oven-burner conversion?

B. Stawicki, West Willington, Conn.

You may already have the orifice you need. Look behind the nameplate, usually located on the bottom storage drawer. If an orifice is stamped with a 6 or 7 or painted red, it is for LP; with a 12 or 13 or painted black, it's for natural or mixed gas; with a 16 or brass-colored, for manufactured gas. Usually they should be fitted to the oven pilot and any side tower pilots.

Some gas ranges have adjustable orifices. The pilot orifices are usually adjusted by a screw located on the pilot gas line, and the oven pilot by a screw near the thermostat valve. The burners themselves may have universal hooded adjustable orifices.

Changing or adjusting orifices on gas equipment should be done by a qualified gas-service technician who will use a manometer to be sure that the gas flow is correct. And whenever a range is moved, as yours was, be sure that all tubing is tested for leaks.

Ceiling fans

I have seen ceiling-mounted fans (the old "drugstore" variety) advertised as energy-saving devices. Can they possibly have any merit from this standpoint?

Mary Jackson, St. Louis, Mo.

Yes, in the right applications. In summer, the evaporative effect of air moving across your skin makes you feel cooler. In winter, these fans are useful with high ceilings since they can force hot air down, reducing stratification and making temperatures more consistent.

Got a home-equipment problem? Write to Evan Powell, Housepower, Chestnut Mountain, Rte. 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Sorry, but unpublished questions cannot be answered by mail.

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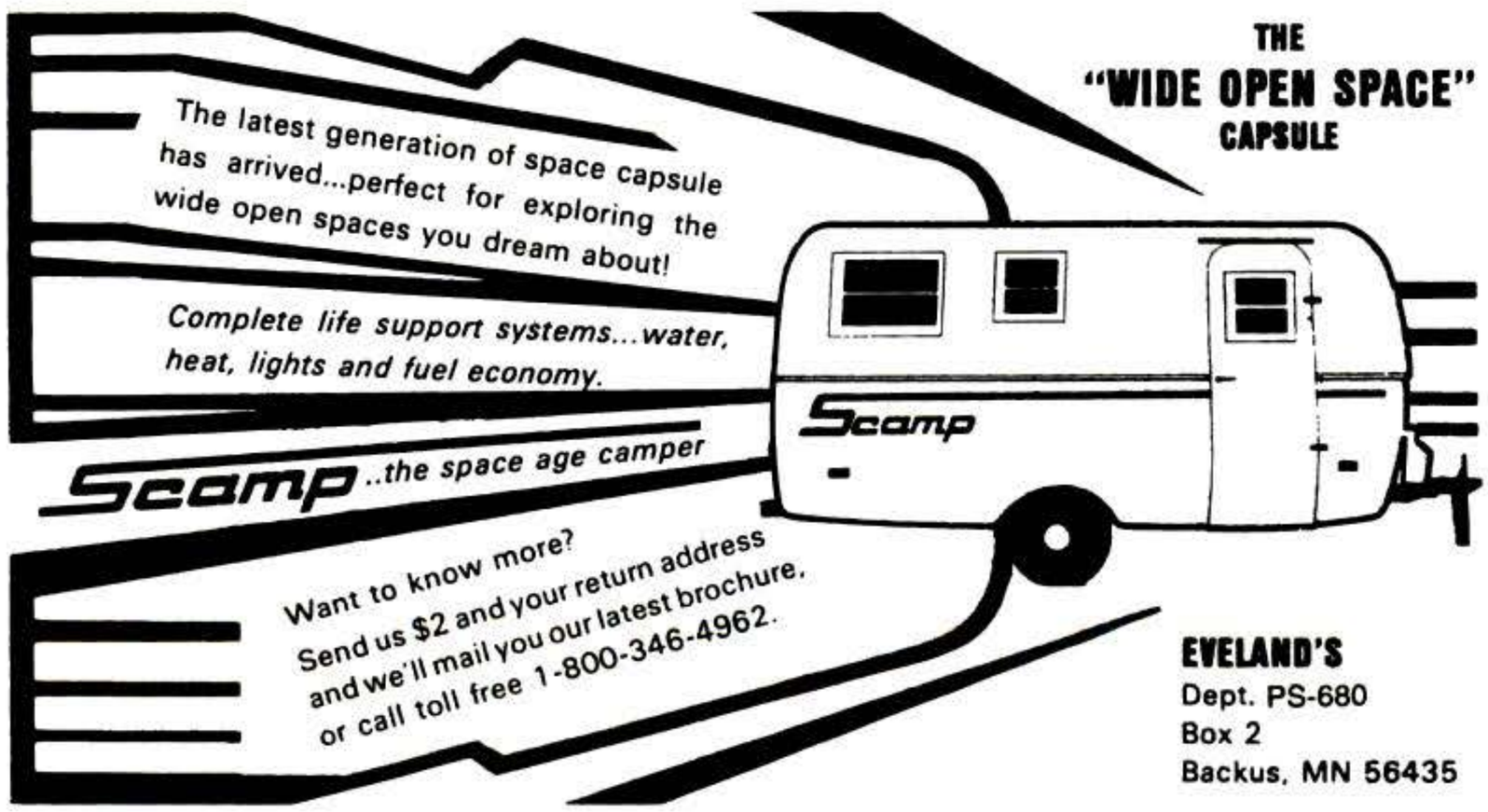


Outboard steerers

[Continued from page 87]

It takes five complete wheel revolutions to swing the outboard through its full left/right turning radius—compared with 3½ or four for conventional mechanical steering systems. This permits more precise steering control at high speeds. And there's no extra play at the wheel.

Best of all, as my tight turns proved, no torque is transmitted from the outboard to the wheel. Thanks to the "push-push" steering, I felt no change in the wheel even when the outboard was trimmed all the way in or out—two extremes almost guaranteed to produce troublesome feedback for mechanical steerers.

The SyTen is designed for outboards of 75 hp and up. I didn't test the unit with dual engines, but Teleflex says that an optional tie-bar kit ($130) enables SyTen to handle a pair of large V6 outboards easily. SyTen prices vary with hose length, and start at $450.

Simple auxiliary steerer

I did use two engines for my test of OMC's new auxiliary outboard steerer—a large, 75-hp powerhead mated with a 15-hp auxiliary.

Rising fuel prices have made this engine combination attractive to offshore outboard skippers who use the small engine for trolling and for emergency get-home power. In my tests, I've found that a 10–15-hp kicker can maintain adequate trolling speed while using a third to a fourth as much fuel as a large V4 or V6 engine. But steering the auxiliary from the helm has been impossible without a separate, expensive steering system.

OMC's inexpensive ($60) new tie-bar kit handles outboards up to 15 hp. Though designed for use with the OMC auxiliary motor bracket, the steerer will work with other brackets—if they position the outboard identically when it's running. The auxiliary must also be port-mounted, with at least 29 inches between its centerline and that of the main outboard. And the transom cutout must be wide enough to prevent binding when the tie bar is hooked up.

In open-water tests I found that the OMC tie bar didn't affect steering ease—and the smaller engine added no detectable steering drag.

The OMC kit, however, provides no way to control the auxiliary's throttle or gearshift from the helm. But this shouldn't be a problem when slowly trolling in open water. If auxiliary helm control in tight quarters is desired, a second set of cables can be installed. PS

PS readers talk back

[Continued from page 4]

I learned in apprentice school that plumb lines are indeed not parallel. Your readers and Mr. Ingalls can check this by referring to Audels *Masons and Builders Guide,* Vol. 1.

Emmett Shaffer, Navarre, Ohio

More on *meters* and *metres*

In your April issue [RTB], reader R. E. Meyers remarks about the spelling of *meter* and *liter.* According to the decision of the U.S. Metric Board, established by the Metric Conversion Act of 1975, Public Law 94-168, the proper spelling in the United States is *meter* and *liter,* conforming to the typical ending in American usage of *-er* instead of *-re.*

This decision is entirely proper, since these units are similarly spelled according to local language usage everywhere else in the world. Thus we join the Germans, Austrians, the German-speaking Swiss, the Flemish-speaking Belgians, the Hungarians, Dutch, and Scandinavians in using *meter* and *liter.* The French and the French-speaking Belgians use *metre* and *litre.* The Spanish, Portugese, and Italians use *metro* and *litro;* the Russians use *metr* and *litr.*

G. E. Westerlund, Chief Engineer
ESICO, Inc., Deep River, Conn.

Wrong ohms

The sketches in Ray Hill's April article "You Can Troubleshoot Your Car's Electronic Ignition" contain a repeated small error. The auxiliary resistance in Chrysler's ballast resistor is 5.0 ohms. The compensating side has resistance of 0.5 ohms. Both are rated 0.5 ohms in illustrations three through eight on pages 118 and 119.

Dr. Herbert L. Hartley, Edmonds, Wash.

You are correct.

Hypar birdhouse

Just for kicks I built a birdhouse using the "Hypar Structures" technique described in your February article. It is everything you said it is: easy to build, strong, permanent, and watertight. Somehow I didn't achieve the aesthetic effect of the pictures you published, however. My birdhouse looks like a one-eyed snapping turtle with a hangover. I just installed it in a tree and am anxiously awaiting a tenant.

Judd H. Black, Rochester, N.Y.

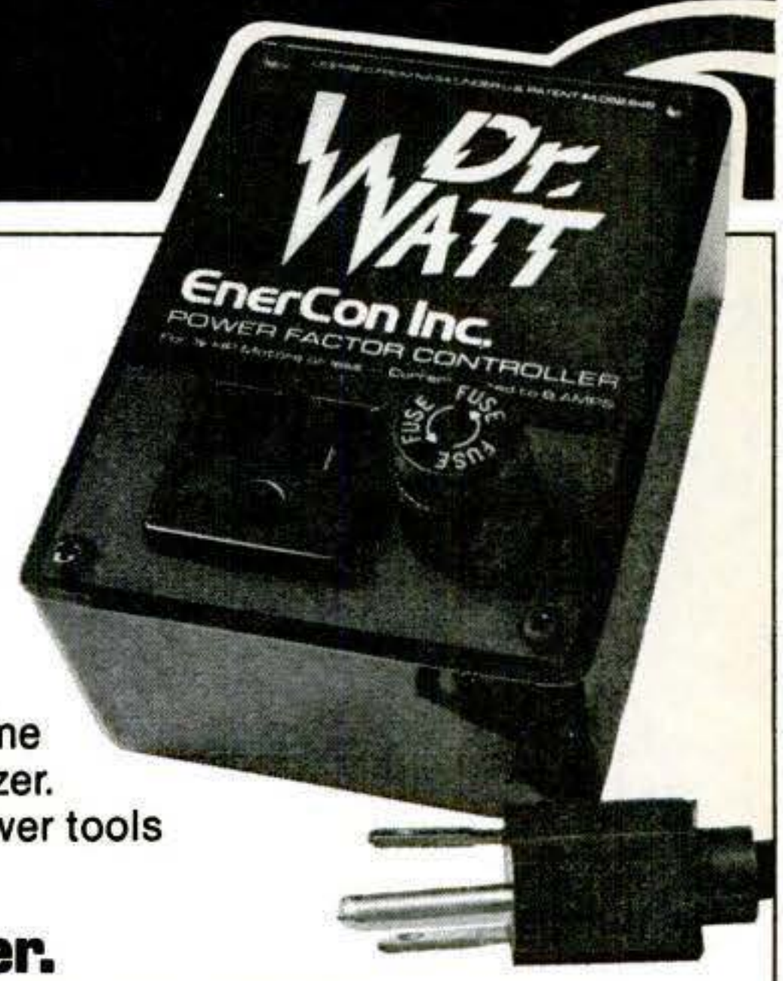
Yes, you don't need a license

In your March story "Tune in Satellite TV," you say that in October 1979 the FCC lifted the requirement that television-receive-only antennas be licensed. The March-April 1980 issue of *Elementary Electronics* states that FCC licensing is still required. Who's right?

L. M. Cotton, New Bern, N.C.

We are. PS

Dr. Watt is no fly-by-night energy saver.



The National Aeronautics & Space Administration holds the basic patent.* Their device was developed to get the highest efficiency possible out of motors which would run on solar energy.

EnerCon, under licence from N.A.S.A., developed Dr. Watt to cut the power used by induction motors of ½-hp., or less. The kind that run home appliances. Your refrigerator and freezer. Your washer and sump pump. The power tools you have in your workshop.

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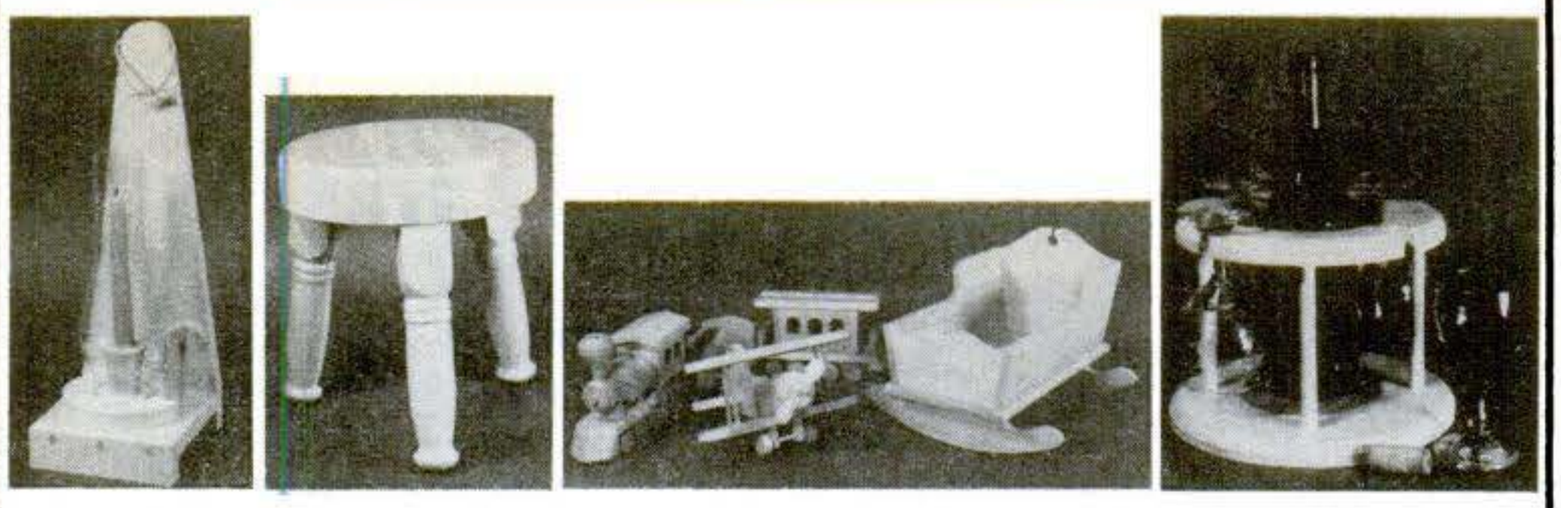

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Dual-fuel motor homes

[Continued from page 90]

start to 60 mph on gasoline and 27.7 seconds on propane fuel. The Midas, powered by a Chevrolet 454-cu.-in. V8, averaged 18.8 seconds on gasoline and 21.8 seconds on propane.

This apparent slowness was not actually noticeable in standard driving situations. And I tend to drive a motor home more conservatively than a car, so I don't think that is a handicap.

We were unable to conduct any comparative fuel-economy tests because there was no way to accurately measure the amount of propane burned with the equipment at our disposal. Propane, however, has about eight percent fewer Btu than gasoline. Spokesmen for Midas and Winnebago told PS that their tests indicate that motor homes would not suffer a full eight percent drop in miles per gallon on propane, but LP fuel economy is poorer than that of gasoline. With propane priced much lower than gasoline, though, the cost per mile traveled would be less with propane.

Just how much money you can save running on propane, however, depends on where you live. In New York, where I drove the motor homes, I paid as much as $1.37 a gallon for propane. But in the Chicago area, propane costs about 75¢ a gallon, substantially less than regular gasoline. And gas companies surveyed by PS indicate that propane costs as little as 70 cents a gallon in some areas.

What about availability of propane? There are about 25,000 LP outlets in the U.S., according to the National L.P. Gas Assn. (1301 W. 22nd St., Oak Brook, Ill. 60521), which offers a directory ($1) of 4000 outlets.

One special difficulty I encountered in filling the motor home's propane cylinders is that many LP dealers fill without using flow meters to measure how much propane you're getting. They fill the cylinder until the relief valve vents gas, signifying it's full. Thus, unless you start with a totally empty cylinder, you don't know exactly how much you get, even though you're charged for a full tank.

How many miles you'd have to travel before you recovered the initial cost for the dual-fuel option depends on the use you give your motor home. Winnebago charges anywhere from $558 to $1200 for dual-fuel systems, depending on the one you select. Midas' price is about $1200. My belief is that it would not be economically justified at standard prices, but it does give you insurance. If you run out of gasoline and can't find a station open, the propane might get you to an area where gasoline is available. PS

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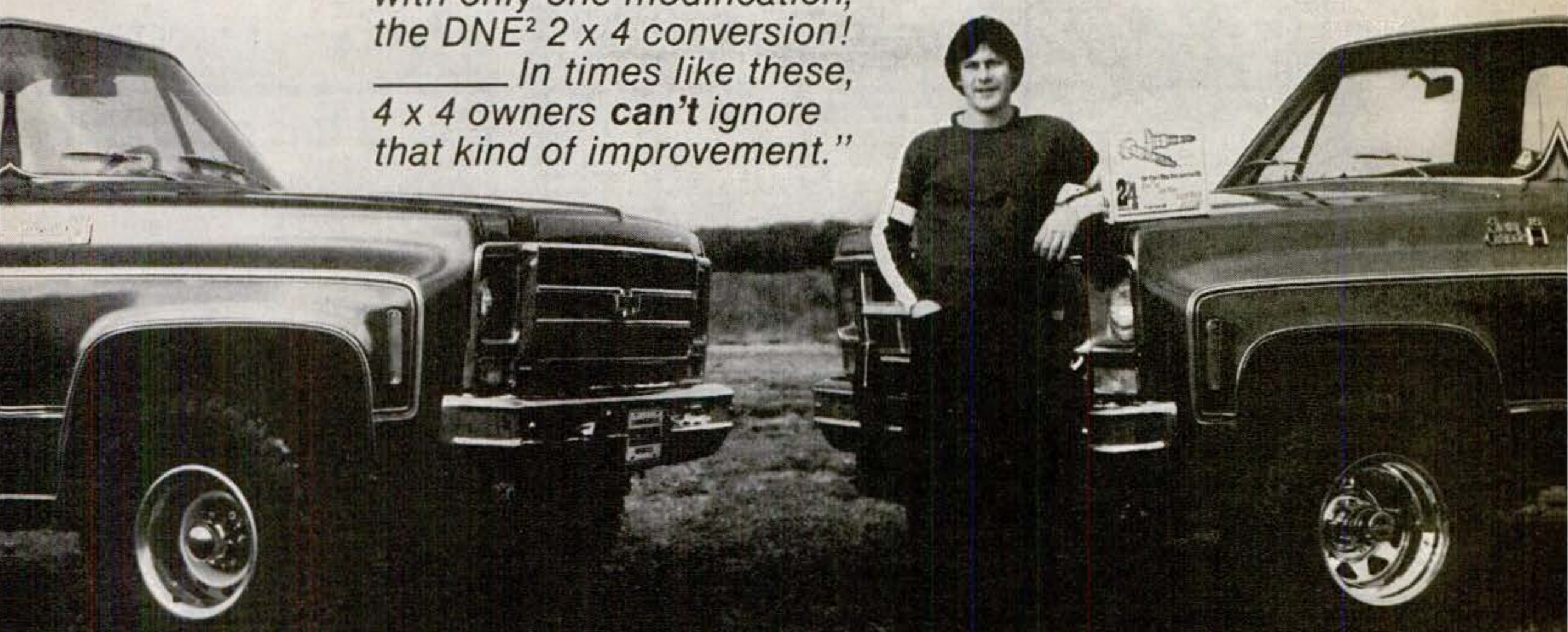

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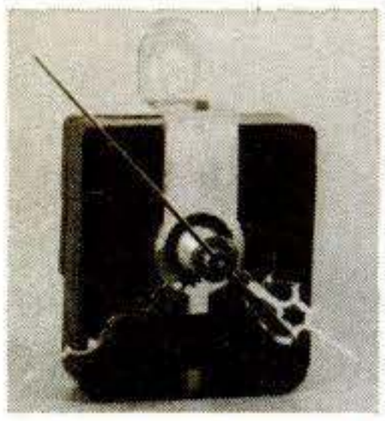

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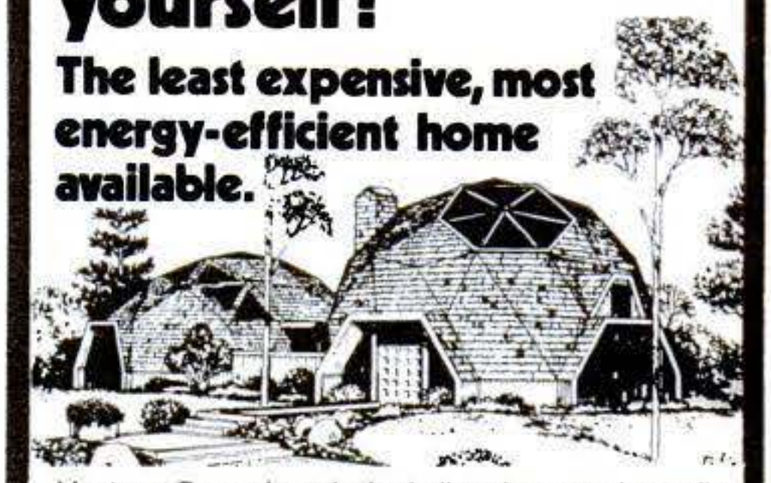

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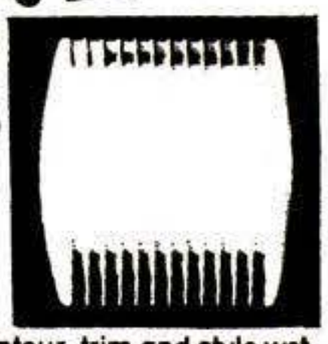

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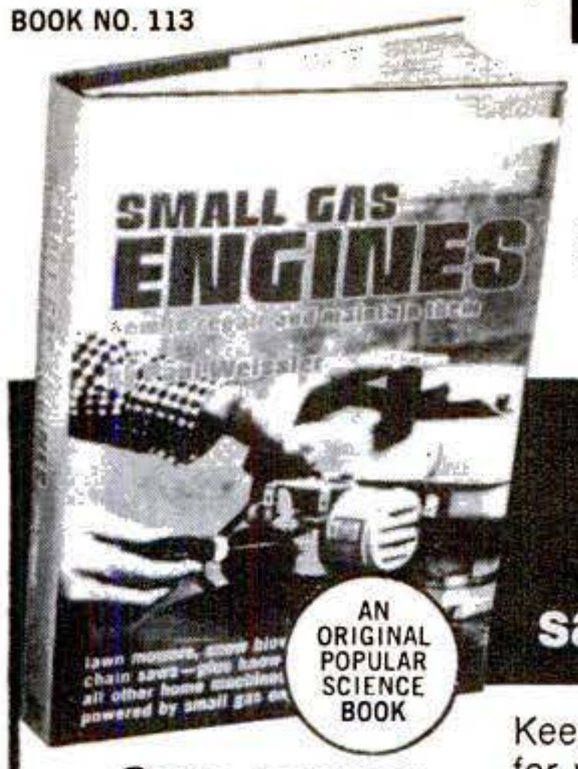

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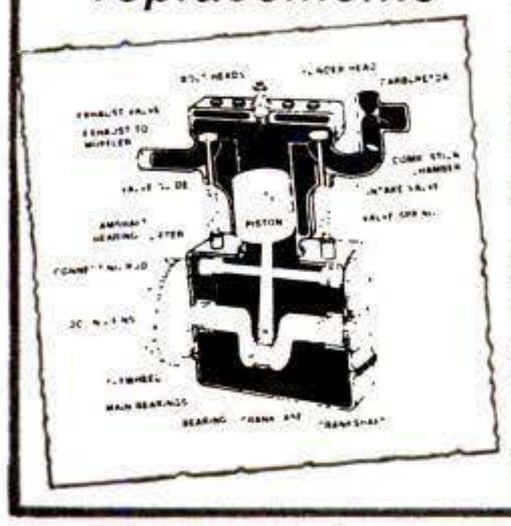

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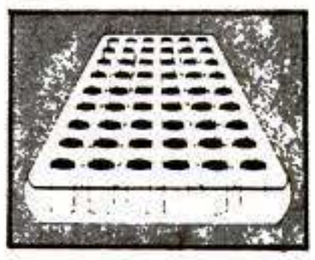

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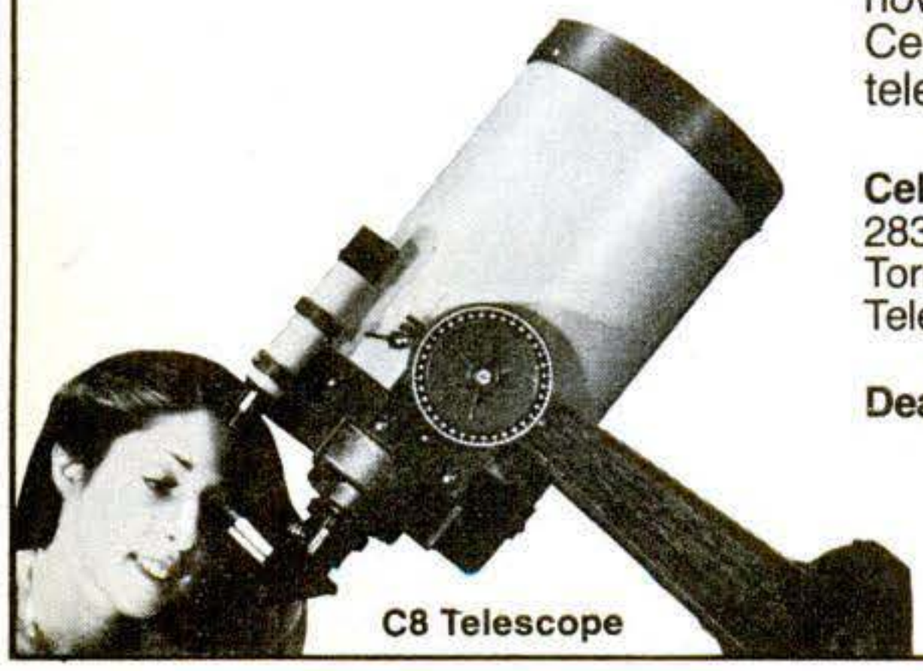

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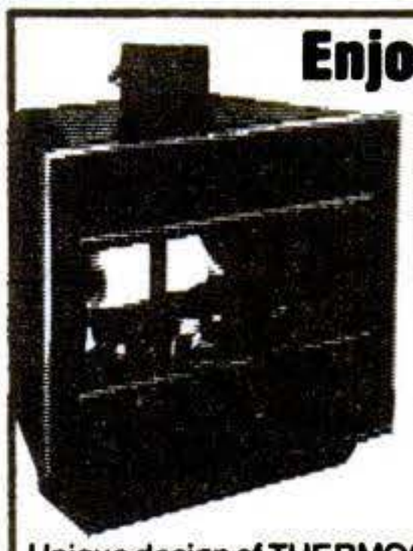

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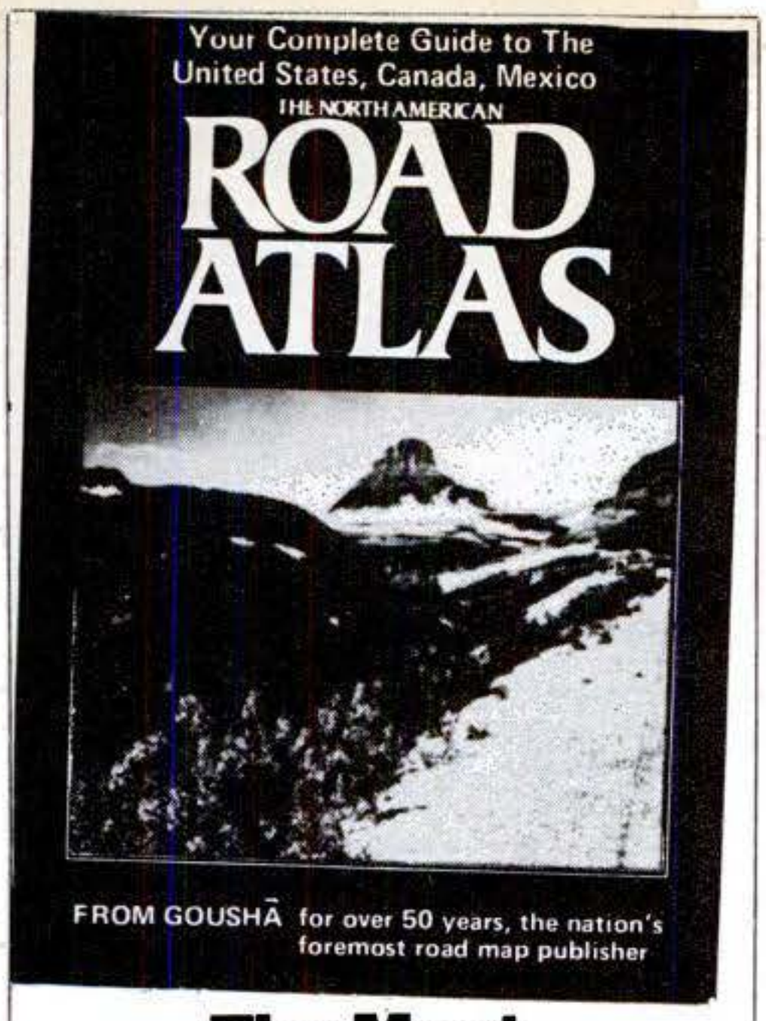

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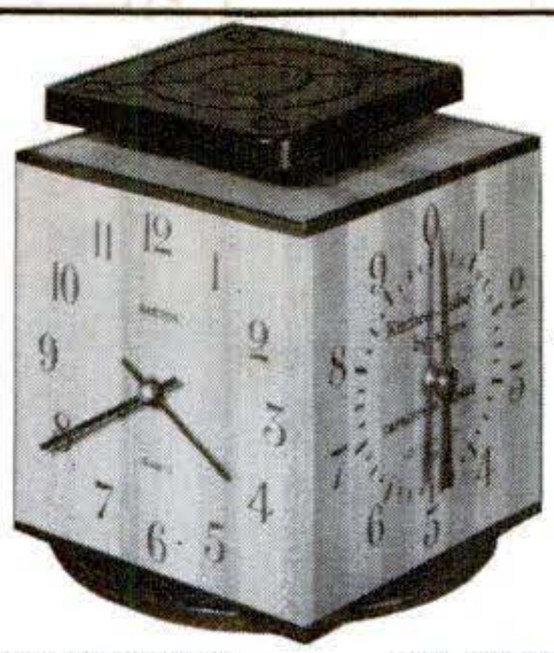

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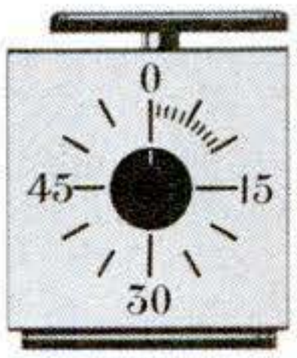

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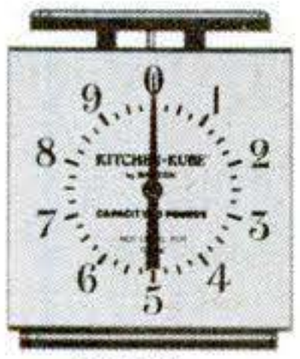

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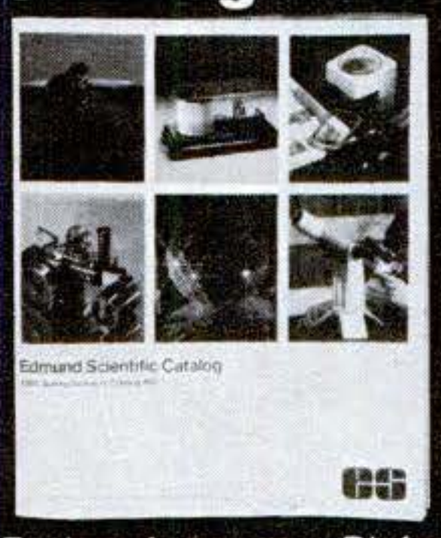

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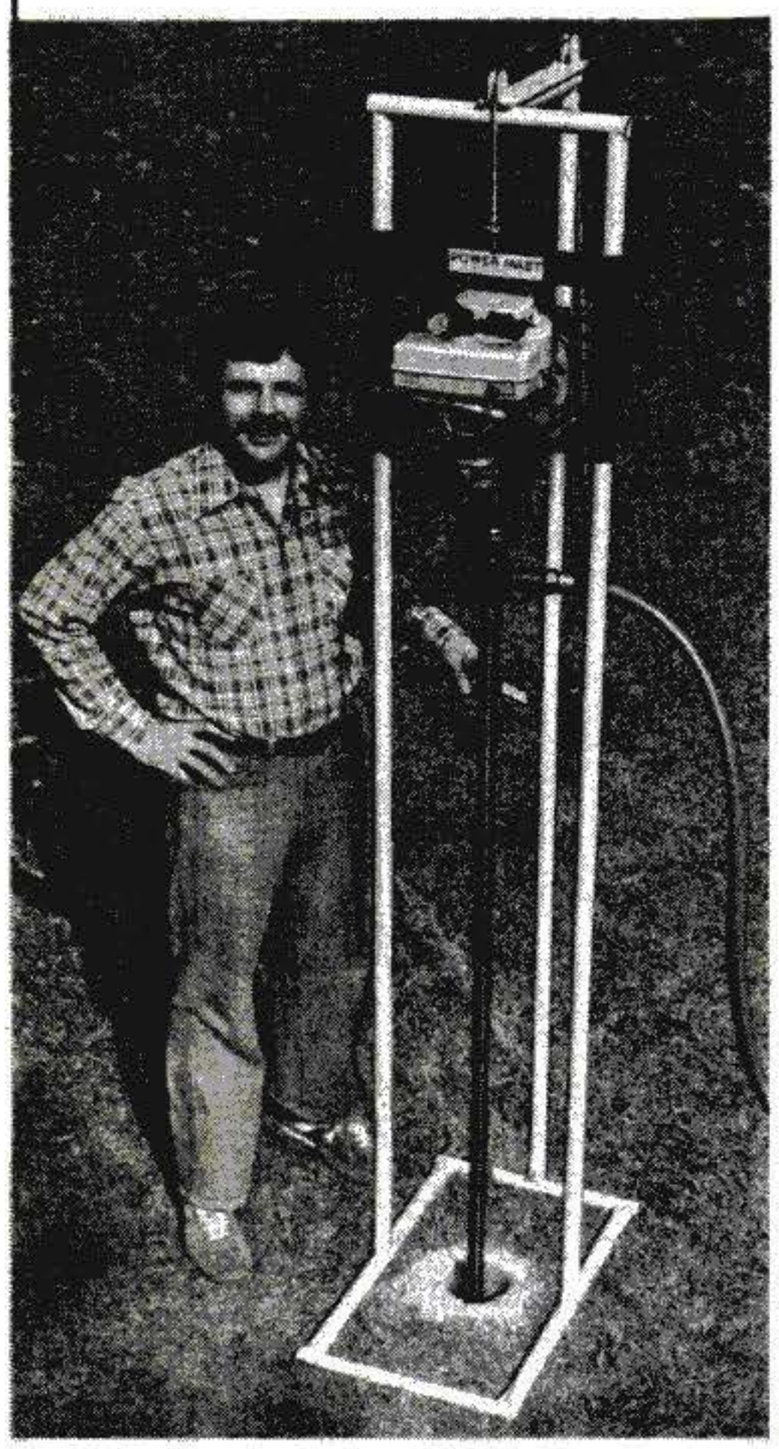

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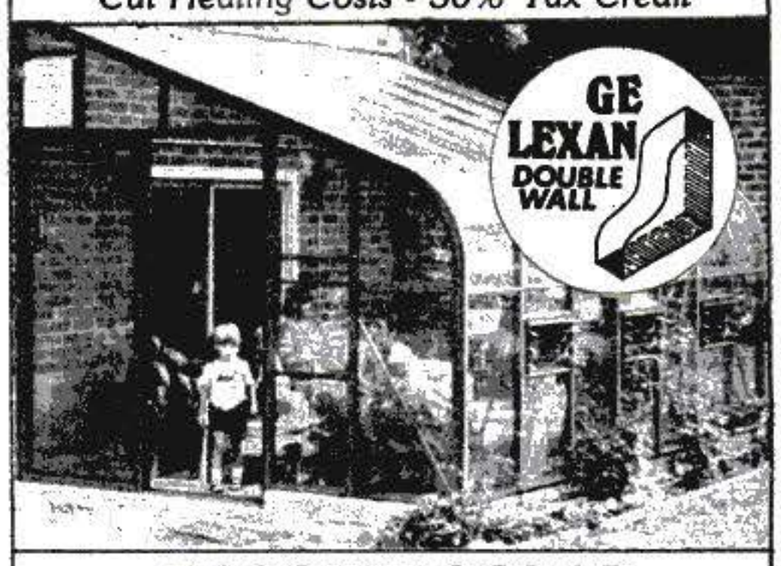

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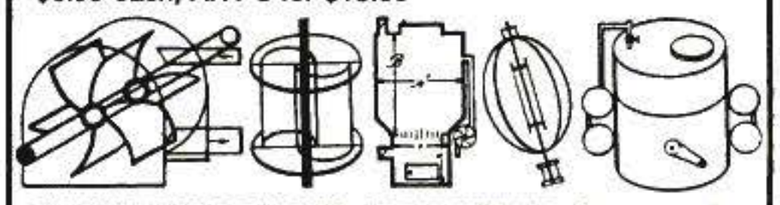

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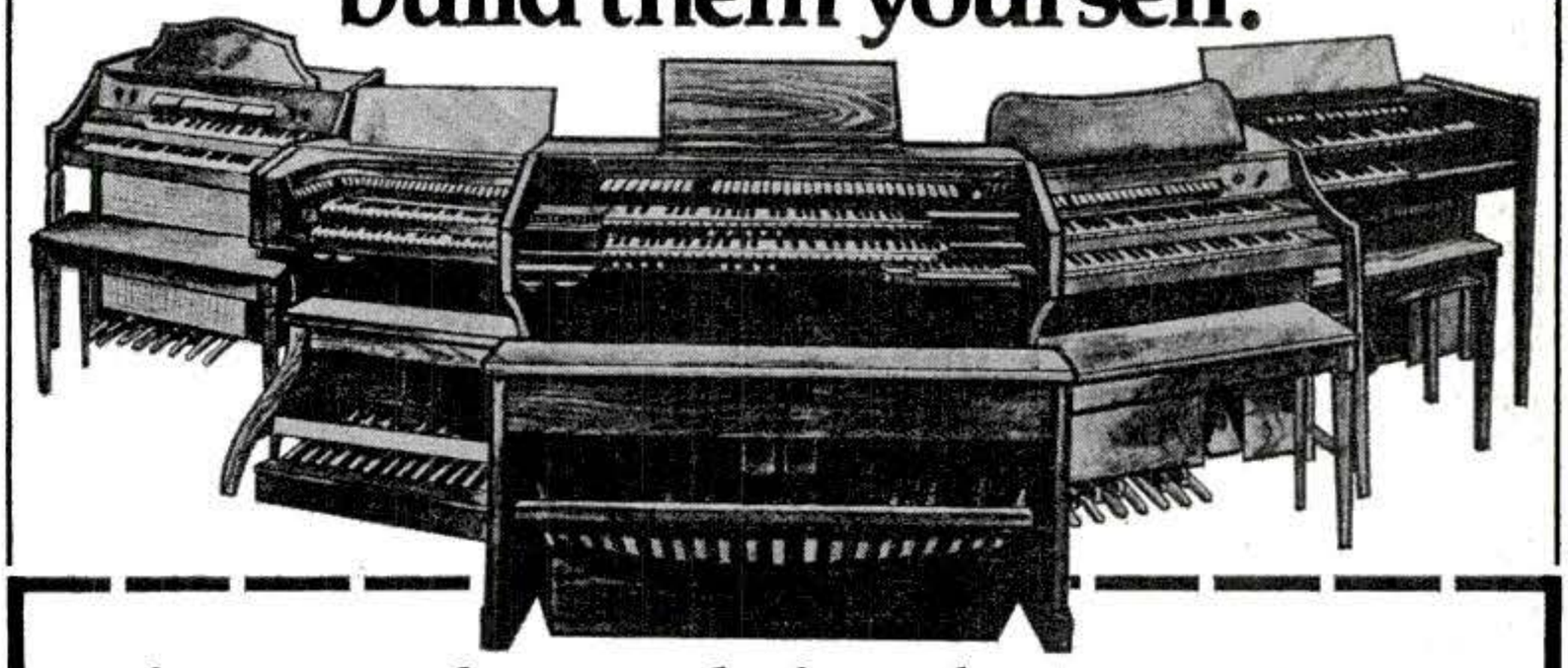

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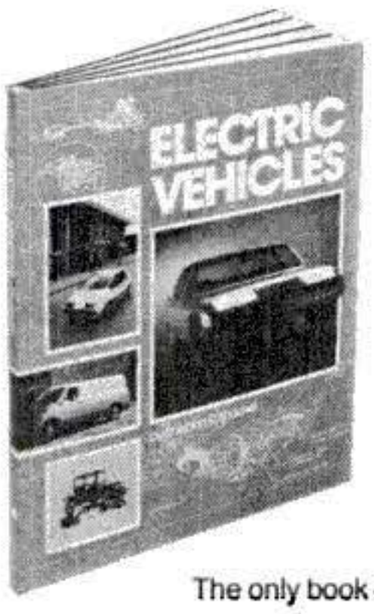

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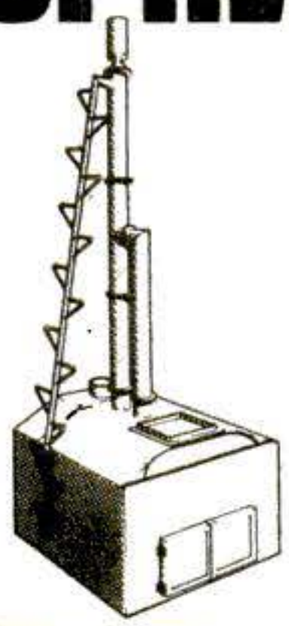

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All of Mother's Plans come with a no-risk guarantee: If after 10 days you decide not to use your plans, you can return them for a full refund of your purchase price.

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Mother's Plans
P.O. Box A
East Flat Rock, N.C. 28726

Or use your Master Charge or BankAmericard/VISA. Send the account number, expiration date, and Interbank Number (for Master Charge only) to the above address, or call in your order TOLL-FREE by dialing: **800/438-0238.**

MOTHER'S PLANS, Dept. 400302, P.O. Box A, East Flat Rock, N.C. 28726

Enclosed is $15.00. Please send me ☐ 6" Column Still Plans or ☐ 3" Column Still Plans. I understand that I have 10 days to examine the plans and if I decide not to use them, I can return them for a full refund.

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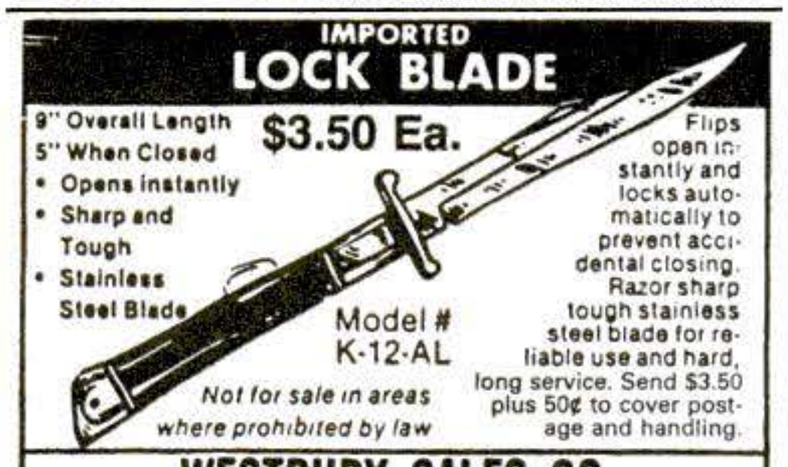

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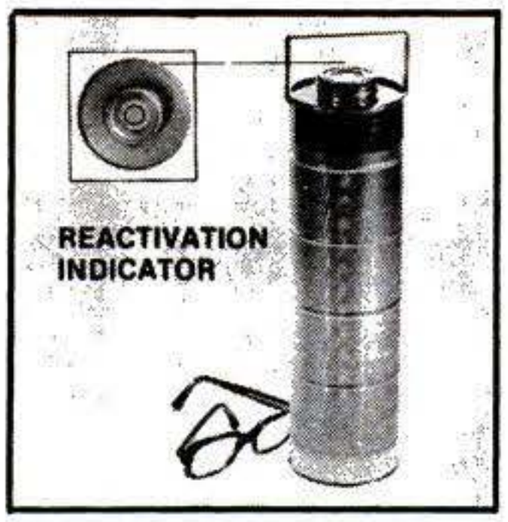
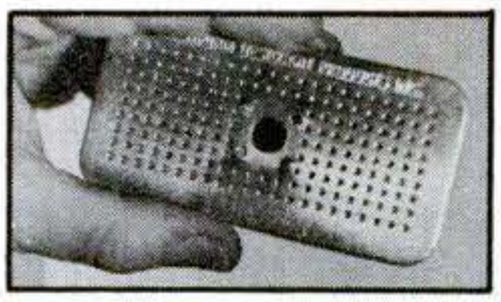


2000 Gram Cannister: This new self-contained unit lasts a lifetime. Reactivates indefinitely. Only 14"x6" yet can protect 144 cubic feet of enclosed space. Used on naval vessels. Ideal for camper-trailer, gunroom, workshop. Steel construction with precision-cut side breathers to silica gel crystals within. Built-in indicator signals when unit should be reactivated. (Reactivates easily in any oven.) This unit can prevent thousands of dollars damage due to rust, dampness, mildew. **$35.00 prepaid.**



Compact Unit: Light weight metal cannister designed to withstand years of use. Excellent protection for individual gun and camera cases, tackle boxes, silver drawers, etc. Protects 3 cubic feet of *enclosed* space. When monitor *"window"* turns pink, unit can be easily reactivated in any oven. **$4.95 pre-paid.**

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☐ 360 Gram Unit: **$8.50 each**
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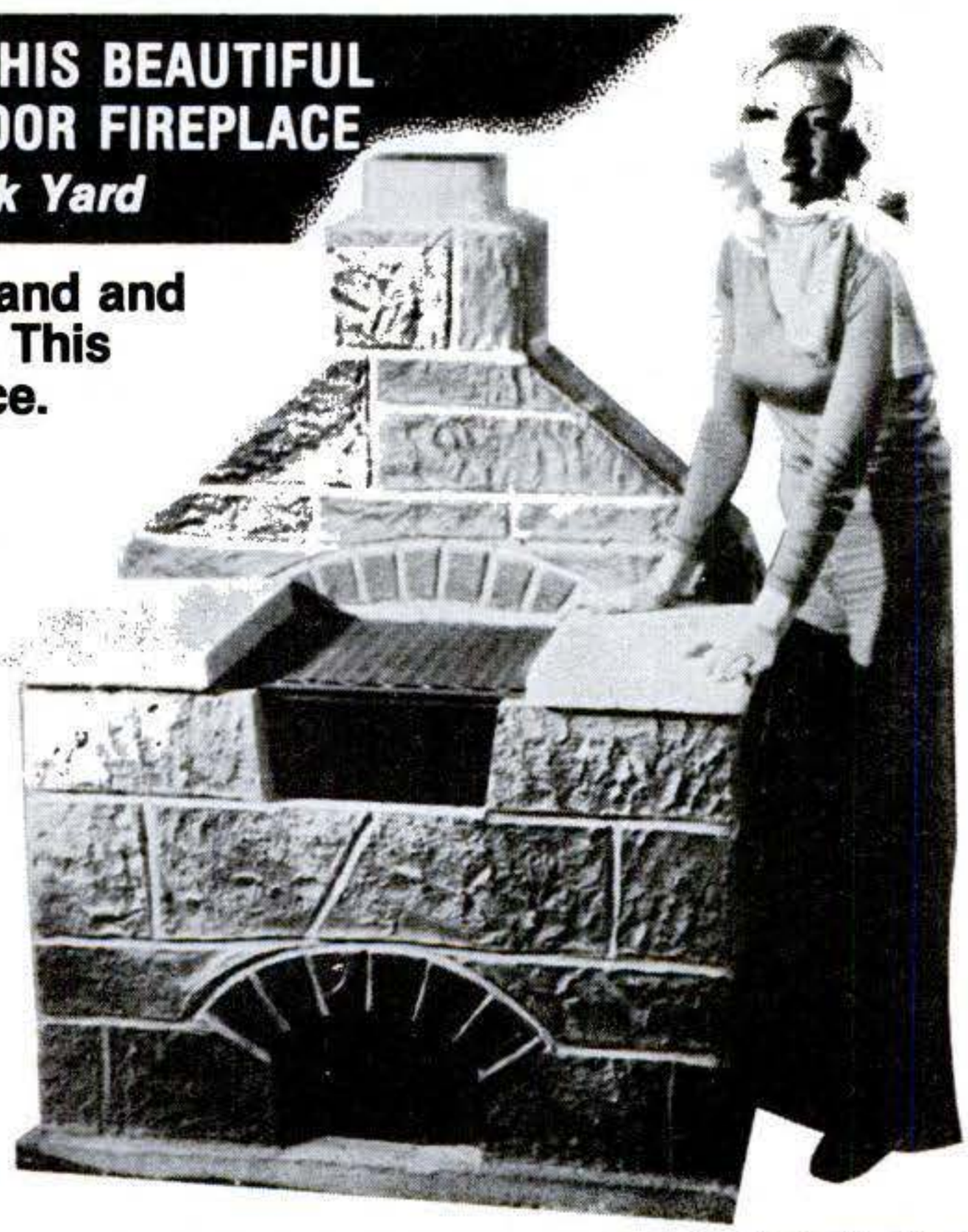

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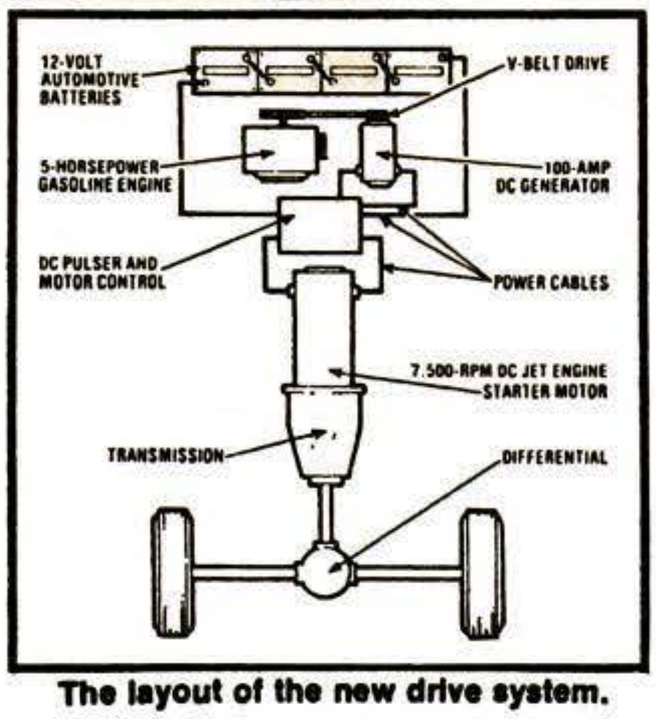

The layout of the new drive system.

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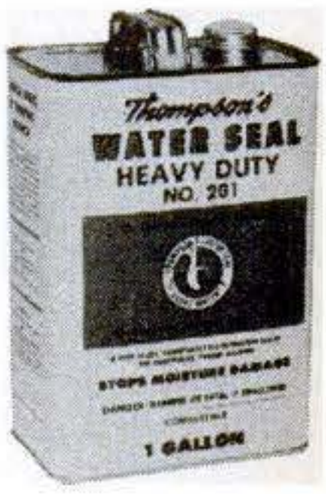

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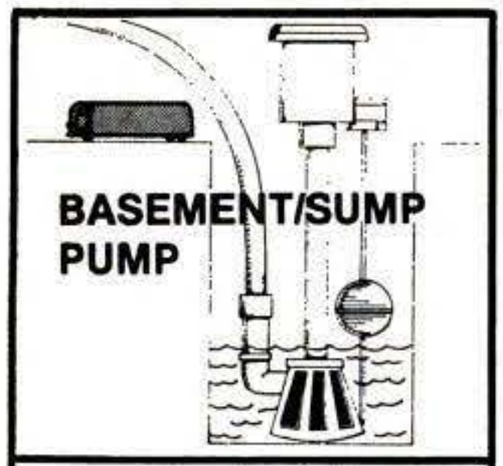

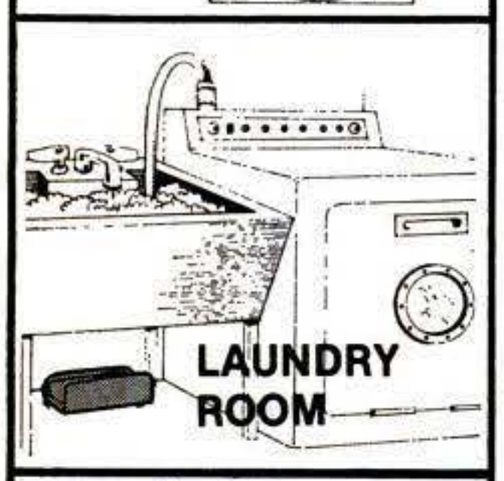

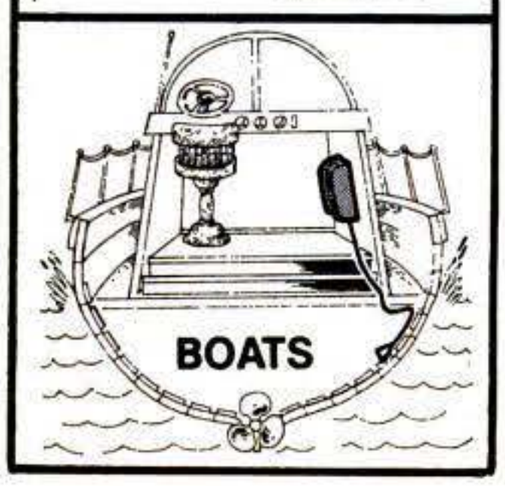

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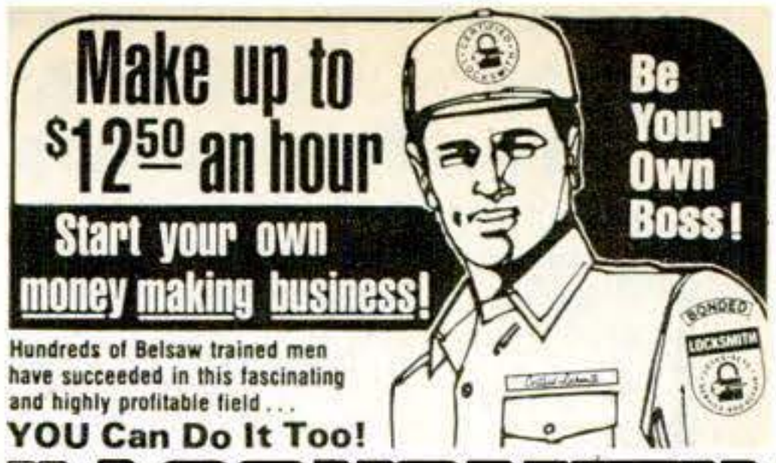

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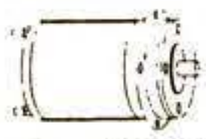

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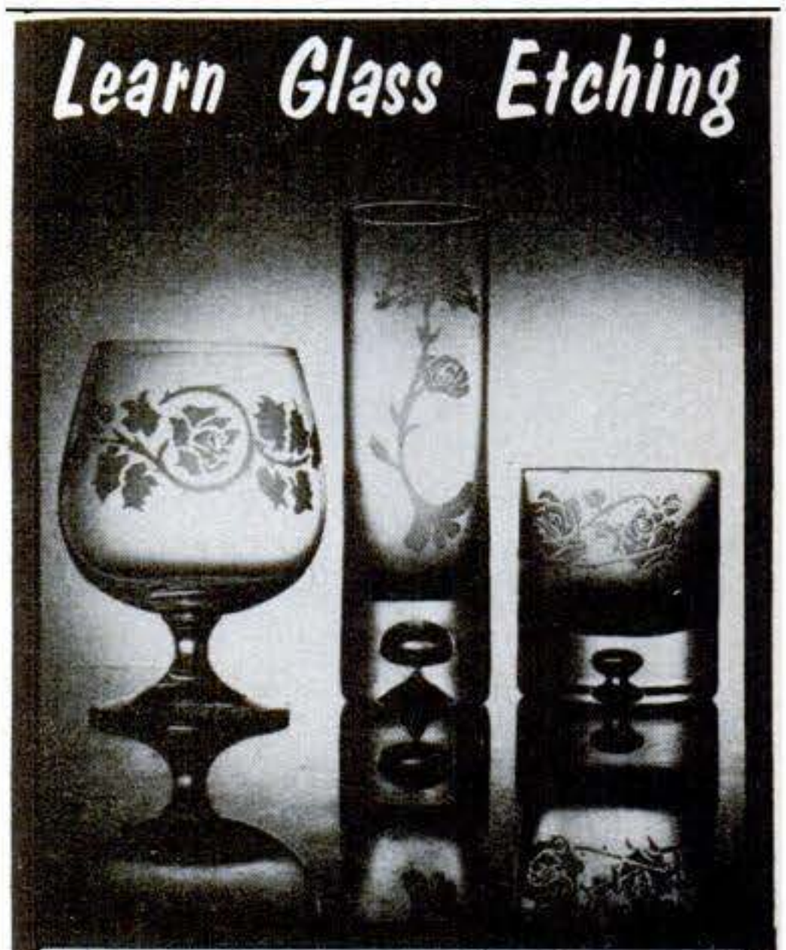

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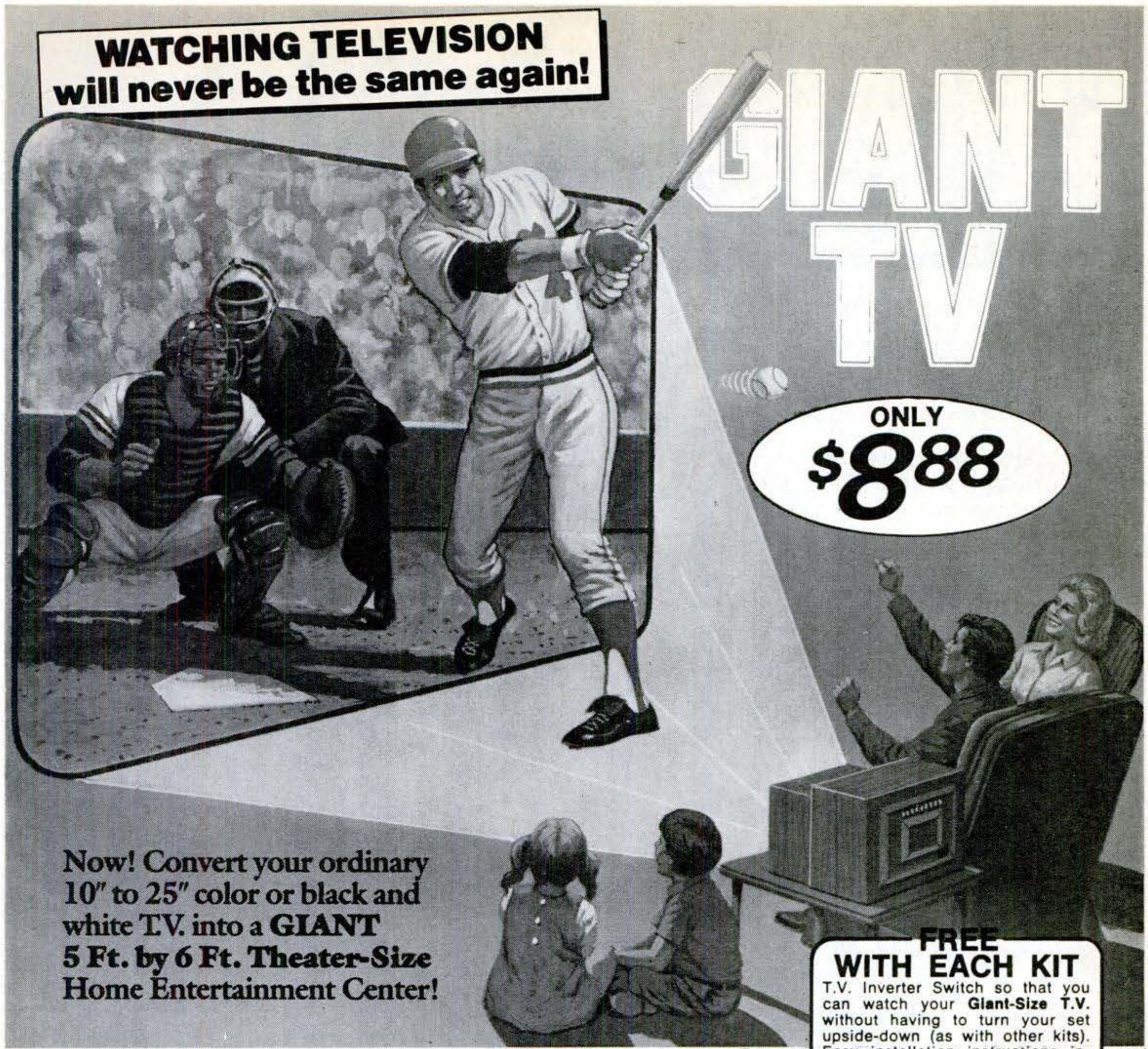

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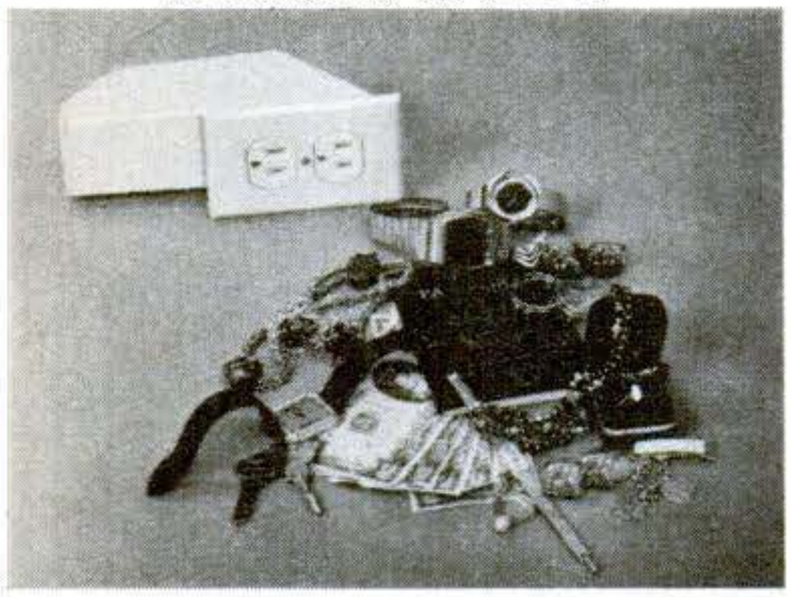
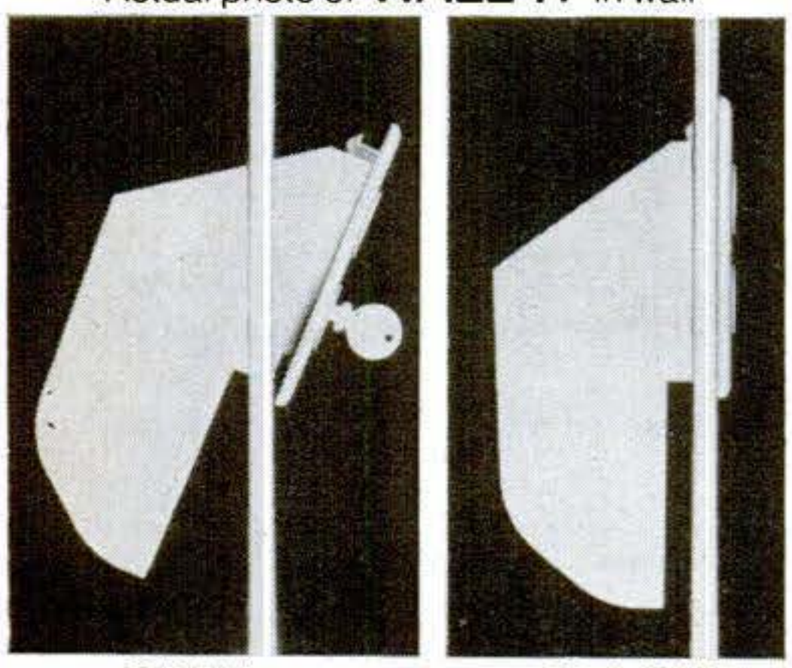


Actual photo of **WALL-IT** in wall



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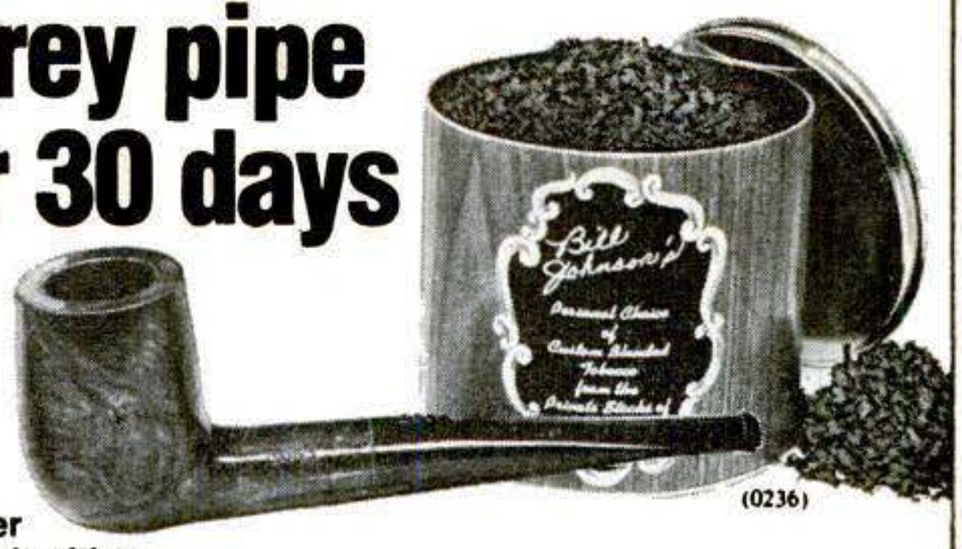

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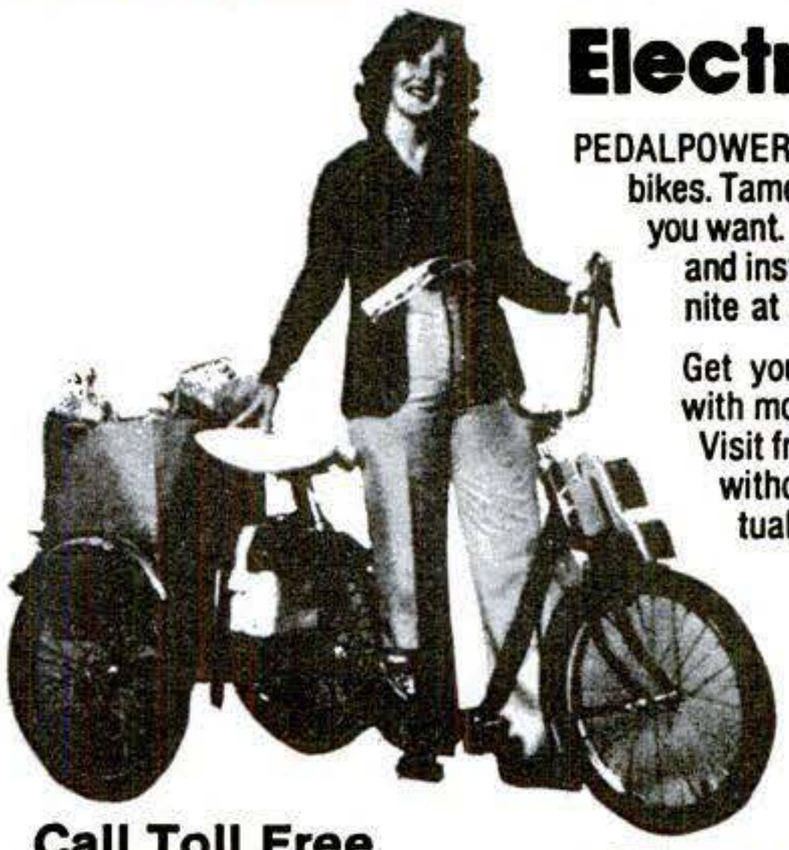

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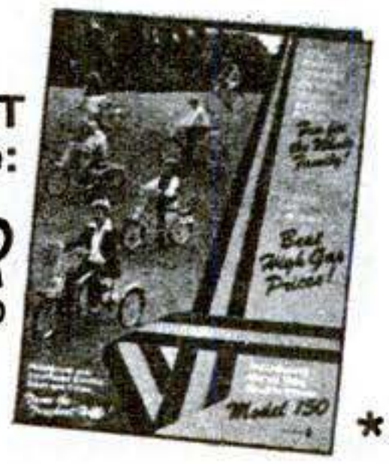

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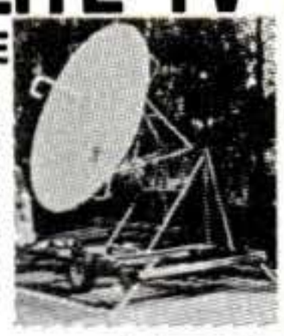

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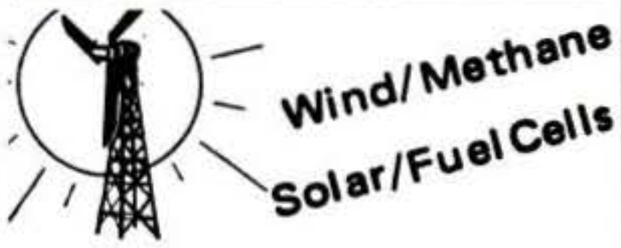

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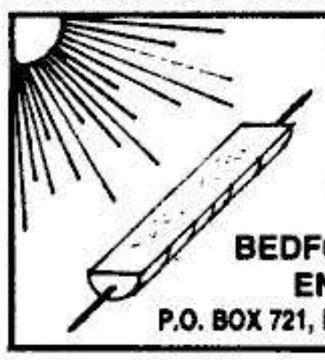

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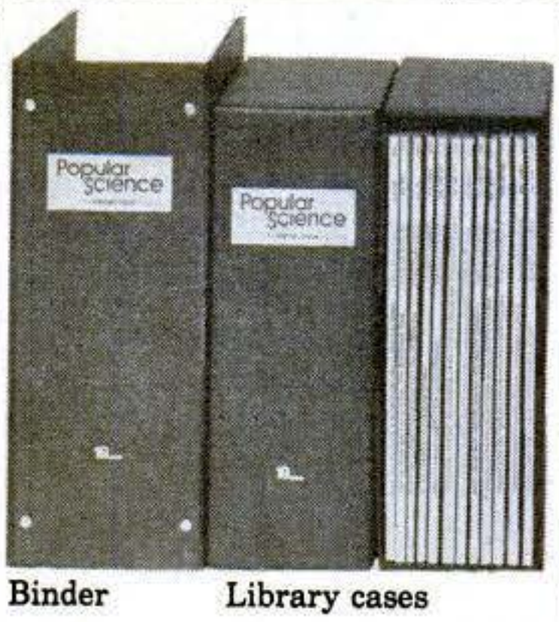

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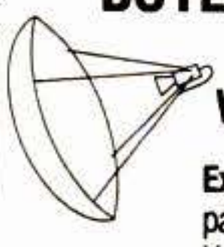

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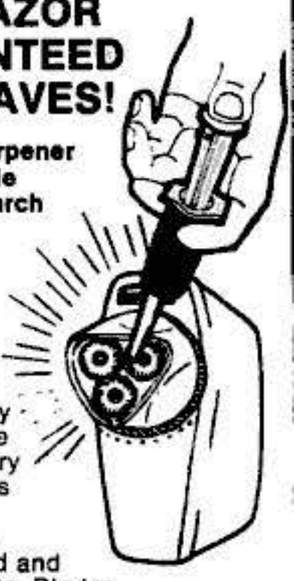

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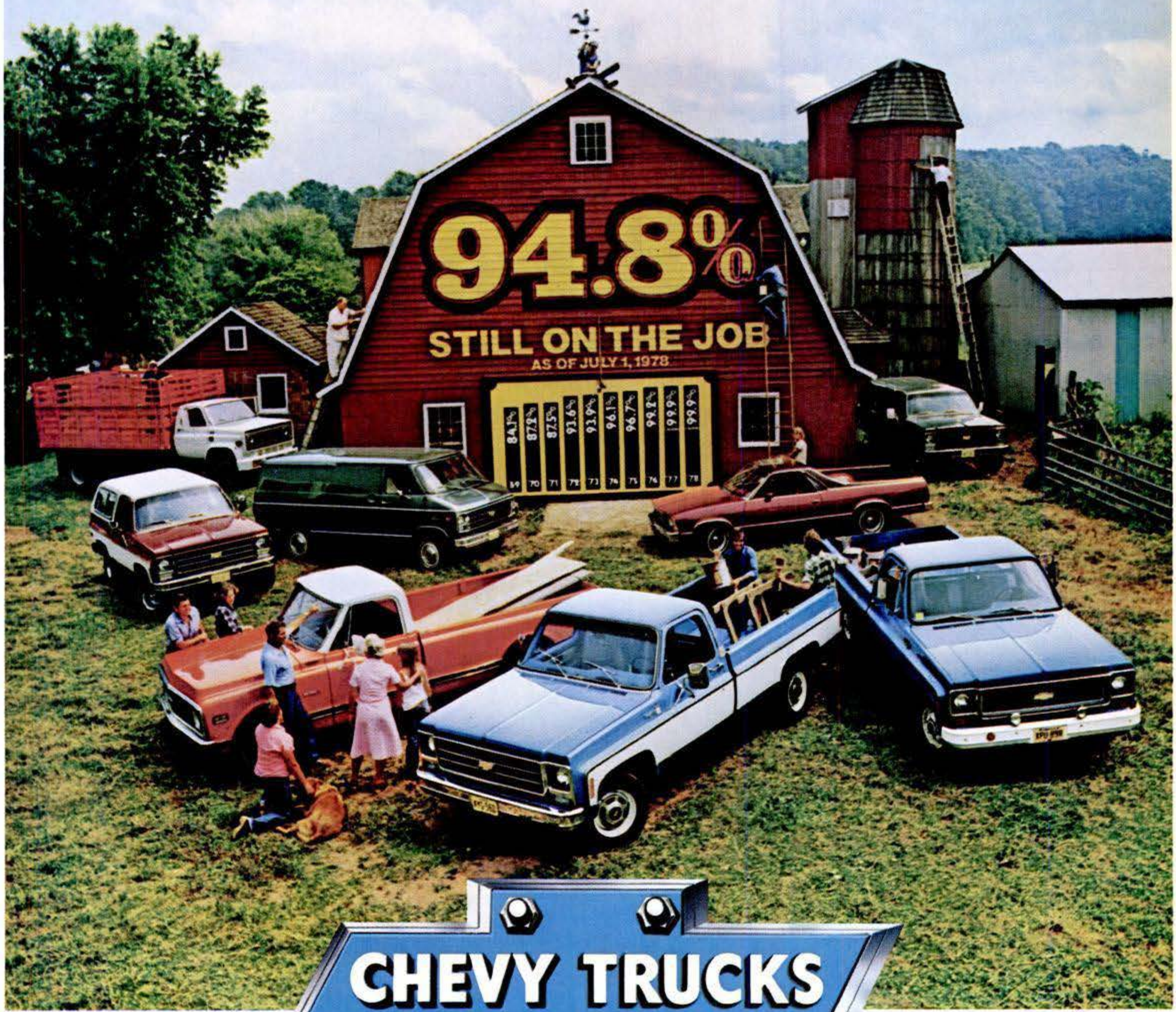

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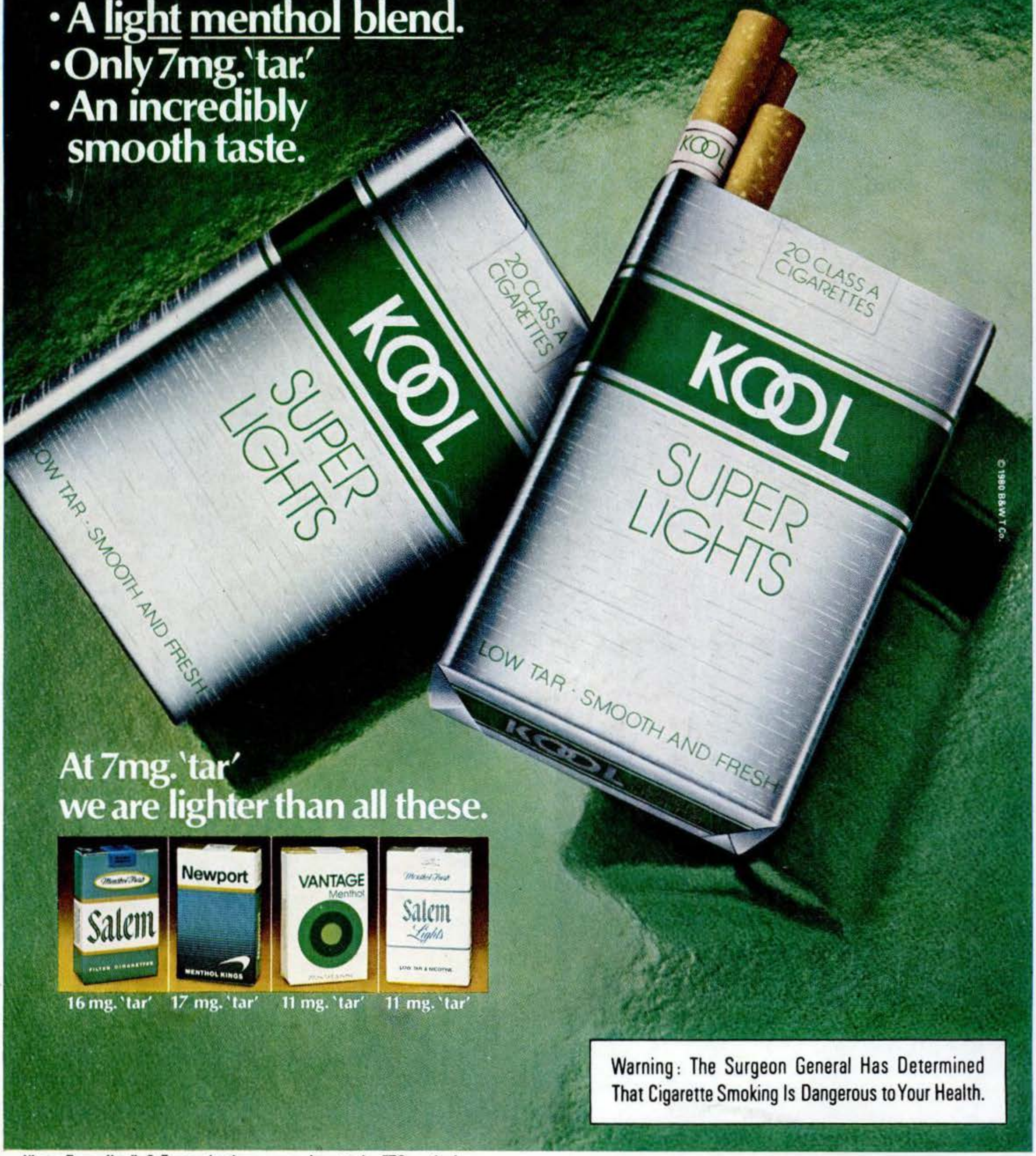

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